Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Instruments—and AUTOMATION

FOR twenty-six years The Instruments Publishing Co. has served the field of Instrumentation. Recognizing the basic importance of devices for measurement and control long before there was general awareness of the fact, The Instruments Publishing Company has led the movement to make all scientists, educators, technicians, engineers, and production men awake to the existence and uses of instruments for measurement and automatic control.

In this quarter century of service more than 10,000 new instruments were reviewed; thousands of men first learned from the magazine *Instruments* of new principles and new techniques for measurement, analysis, inspection, testing, computing, and automatic control. The many services rendered by *Instruments* are now world-famous.

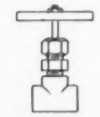
But growth necessitates change. Accompanying the growth of the field of instrumentation have come new markets, new concepts, new terminologies. One word in particular seems to have captured the imagination of the American public—the word AUTOMATION. Easy to say, to spell, to understand, the word captures the motivation of the control aspects of Instrumentation. Hence, for the future, we believe that the services and functions of your magazine *Instruments* can better be expanded and developed by adopting the name. Henceforth, starting in January, 1954, your magazine will be called *Instruments & Automation.*

Including the
JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 1007)
and the
JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 1091)

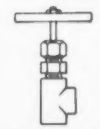
Vol. 26 No. 12
DECEMBER • 1953

HOW TO SOLVE THE *tough* NEEDLE VALVE PROBLEMS

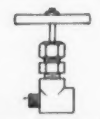
UNION BONNET
ANGLE PATTERN
(Female Ends)



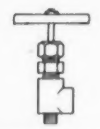
SCREWED BONNET
STRAIGHT PATTERN
(Female Ends)



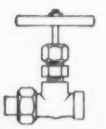
SCREWED BONNET
ANGLE PATTERN
(Female Ends)



SCREWED BONNET
STRAIGHT PATTERN
(Male End)



SCREWED BONNET
ANGLE PATTERN
(Male End)



SCREWED BONNET
STRAIGHT PATTERN
(Union End)

Teflon-packed American Needle Valves "lick" the really tough meter manifold jobs — sour gas, wet gas, odorizing, chemical plant and refinery applications and other difficult and corrosive field services.

Precision machined valve bodies (stainless or carbon steel) are specially suited for welding. Stainless steel valve stems, centerless-ground for exact fit, are designed so that the valves can be repacked under pressure. Positively aligned valve seats are burnished for point-contact seating.

Every valve is hydrostatically tested. Standard valves are designrated for 5000 psi working pressure at 70°F. Valves are also available for higher pressures to 10,000 psi and can be furnished, with graphite impregnated asbestos packing, for temperatures above 450°F.

Write for Complete Specifications.

In actual tests, Teflon packing prevented gland leakage through 124,000 on-and-off cycles, without tightening the packing nut.

AMERICAN®
METER COMPANY
INCORPORATED ESTABLISHED 1836

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
Albany • Alhambra • Atlanta • Baltimore • Birmingham
Boston • Chicago • Dallas • Denver • Erie • Houston
Kansas City • Los Angeles • Minneapolis • New York
Omaha • Pittsburgh • San Francisco • Seattle • Tulsa
IN CANADA: Canadian Meter Company, Limited
Hamilton, Ontario • Edmonton, Alberta

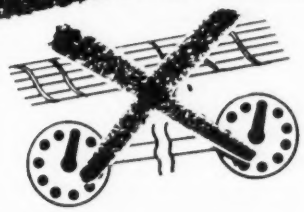
For more information circle **1** on inquiry card.

A new concept in Temperature Monitoring!

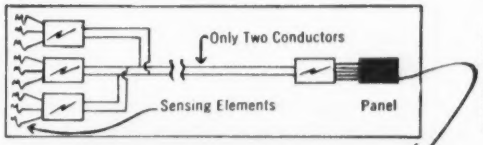
KYBERNETES
ELECTRONIC SWITCHES

NOW *you can* ***replace***
Multiple Conductor Cables
or Mechanical Scanning

WITH—



ELECTRONIC SCANNING
Completely Non-Mechanical and
utilizing only two conductors



Features:

LOWEST INSTALLATION COST

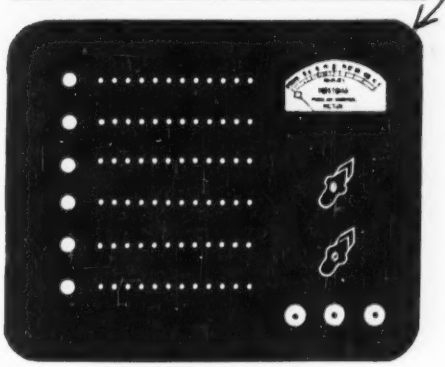
- Utilizes one inexpensive RG-59/U coaxial cable instead of 200 conductors in an average installation of 100 points.

COMPLETE INFORMATION AT PANEL BOARD

- Zone and point alarms.
- Point temperature readings.
- Uninterrupted scanning and alarm indication during temperature reading.

SELF MONITORING

- Alarm and meter indicate failure of any circuit element.



PANEL SIZE MINIMIZED

Zone alarm lights. Point alarm lights. Meter for direct temperature reading. Zone switch. Point switch. Indicator lamp test button. Reset button. Horn turn off.

NOW BEING DEMONSTRATED. ***Write for Specifications 121***

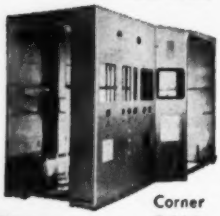
THE
KYBERNETES
CORPORATION
1100 RAYMOND BOULEVARD, NEWARK 5, N. J.
division of SELF WINDING CLOCK COMPANY, INC.

For more information circle **2** on inquiry card.

Quality is assured with
FALSTROM

INSTRUMENT PANELS
and CONTROL BOARDS

Benchboard Console



Five Section Cubicle Control Board and Lighting Canopy

Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

Superior Engineering MAKES
FALSTROM YOUR LOGICAL CHOICE!

Experienced designing and quality fabrication assure the efficiency of any indicating, recording, or control installation. Whether you are planning new construction, modernizing existing installations or adding to present equipment, FALSTROM offers long years of experience and the most modern facilities for fabricating to your specifications or recommending standard designs. In any case, by specifying FALSTROM you specify the highest possible quality metal working techniques known to the industry. Estimates on your needs will be supplied promptly—call or write FALSTROM to arrange a consultation.

WRITE FOR BULLETIN #125

SINCE 1870 FALSTROM COMPANY
92 Falstrom Court, Passaic, New Jersey
DESIGNERS, ENGINEERS AND BUILDERS OF CUSTOM METAL PRODUCTS FOR INDUSTRY

For more information circle 3 on inquiry card.

Instruments
THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Vol. 26 December 1953 No. 12

SERIAL

Nuclear Reactors for Industry and Research
IV. Radiation Protection 1873
By Karl Z. Morgan

FEATURE ARTICLES

Electrolytic-Tinplate Instrumentation 1875
By William P. Smith

Significance of Air Temperature in Open-Hearth Operation 1876
By John S. Marsh

Flow Tubes 1879
By E. W. Randle

A Steel-Plate Thickness Meter 1880
By S. S. Carlisle and R. B. Sims

Bore Profilometer 1882
By S. S. Carlisle and R. B. Sims

Quality Control and Inspection 1884
By W. L. Young

THE MONTH'S NEW INSTRUMENTS 1827
INSTRUMENTS ON THE MARCH 1912
BOOK REVIEWS 1915
MANUFACTURERS' NEW LITERATURE 1917

OTHER REGULAR FEATURES

Editorial Comment: 1953-1954 1825
Instrument Events Calendar 1899
Advertisers' Index 1935

JOURNAL of the
INSTRUMENT SOCIETY OF AMERICA 1887

Applications of the Constant Temperature Hot-Wire Anemometer to the Study of Transient Air Flow Phenomena 1890
By James C. Laurence and L. Gene Landes

JOURNAL of the
SOUTHERN CALIFORNIA METER ASSOCIATION

Installation and Maintenance of Orifice Meters 1895
By W. D. Straight

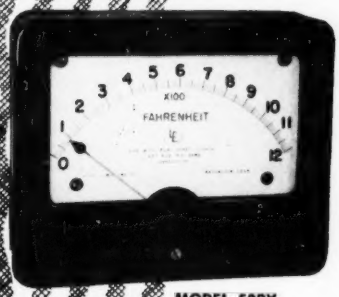
Calculations for Natural-Gas Orifice-Meter Coefficients 1897
By H. R. Garabrant

Copyright 1953 by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.

LEWIS INDICATING PYROMETERS

FOR TEMPERATURE TESTING IN THE LABORATORY OR IN THE PLANE . . .

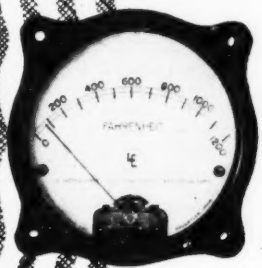
Constructed with the same care as our aircraft temperature indicators, these pyrometers bring "aircraft quality" to the test engineer. Use Lewis leads, thermocouples and selector switches to build complete temperature measuring installations. All models available with black dials and white markings for photographic observers.



MODEL 58PY

This instrument has been used extensively by the leading motor-car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in a rectangular bakelite case, this reliable, fully compensated pyrometer is furnished with 6 in. hand drawn scales for greater accuracy. The Model 58PY is available for use with all standard thermocouple materials, in many ranges to suit the most exacting application.

Accuracy — 1% of total scale deflection



MODEL 23B

Manufactured with the same type of movement as our aircraft pyrometers, the Model 23B pyrometer is well suited for use in moving vehicles and has been successfully used in many test stand installations. It is housed in a 4 in. round bakelite case that is flanged for panel mounting, and is available in several ranges for use with various thermocouple materials.

Accuracy – 2% of total scale deflection

MODEL 20B

The Model 20B series of indicators are patterned after our standard aircraft instruments and are supplied with 3" round steel cases suitable for panel installation. These compact, sturdy indicators have 2⅛ in. scales, are fully cold-end compensated and are available in many ranges for use with various thermocouple materials.

Accuracy — 2% of total scale deflection

STANDARD RANGES, ALL MODELS

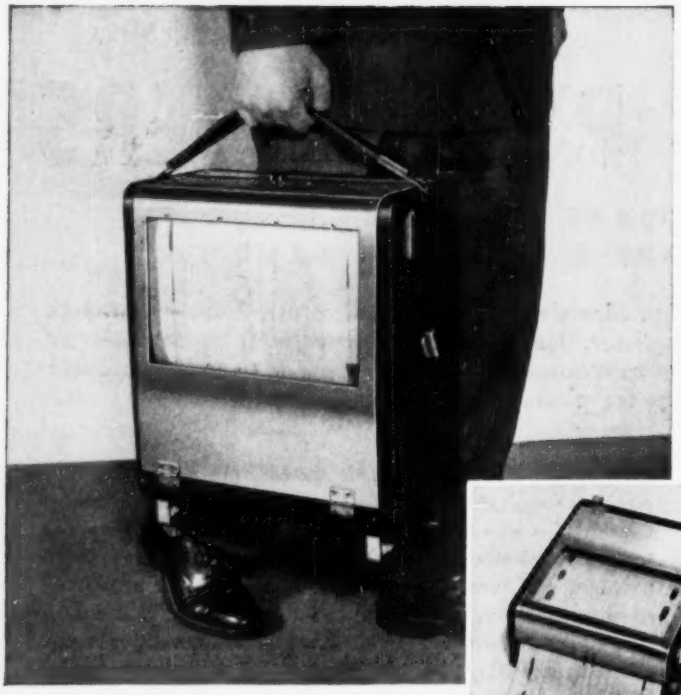
FAHRENHEIT		*CENTIGRADE*	
0 to 400	0 to 1200	0 to 200	0 to 600
0 to 600	0 to 1600	0 to 300	0 to 800
0 to 800	0 to 1800	0 to 400	0 to 1000
0 to 1000	0 to 2000	0 to 500	0 to 1100
0 to 2500		0 to 1400	

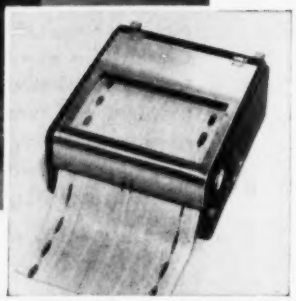
THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

For more information circle **4** on inquiry card.





NEW!

PORTABLE 6-Channel Oscillograph Simplifies on the Job Tests

Now you can easily make multi-channel recordings of electrical or mechanical phenomena in the shop or in the field. This new Brush Oscillograph is lightweight, self-contained, and can be set up readily.

A large window in the top of the instrument permits viewing the chart as six channels are being recorded. Controls provide chart speeds of 5, 25, and 125 mm. per second. The Oscillograph includes a 25-foot length of cable and a junction box providing for all necessary amplifier outlets.

Additional flexibility is provided by a remote control box which is offered as an accessory. With this, the operator can start and stop the chart drive from remote locations. A foot switch can be connected to the Oscillograph or to the remote control station if desired.

Get all the facts on this new Model BL-226 Oscillograph. For bulletin write Brush Electronics Company, Dept. A-12, 3405 Perkins Avenue, Cleveland 14, Ohio. Brush representatives are located throughout the U.S. In Canada: A. C. Wickman, Limited, Toronto.

PIEZOTRONICS... Brush has prepared this informative 24-page brochure describing the functions and applications of piezo-electric materials. Write for free copy—it may spark a product improvement idea.

BRUSH ELECTRONICS COMPANY

BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly The Brush Development Co. Brush Electronics Company is an operating unit of Clevite Corporation.

For more information circle **5** on inquiry card.

Instruments

THE MAGAZINE OF MEASUREMENT INSPECTION • TESTING • CONTROL

Published by
The Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Penna.

Richard Rimbach, *Publisher*
Manoel F. Béhar, *Editor*
Milton H. Aronson, *Technical Editor*
David S. Aland, *Associate Editor*

DISTRICT OFFICES AND MANAGERS

Altadena, Calif., M. D. Pugh, 2721 N. Marengo Ave., Telephone Sycamore 7-2894

Boston 14, James Condon, 133 Marlborough St., Telephone Commonwealth 6-5961

Chicago 1, Harold W. Haskett, Room 2101, 228 N. La Salle St., Tele. Central 6-8963

Cincinnati 5, Harold W. Haskett, 742 Elberon Ave., Telephone Grandview 4323

St. Louis 1, *Mo.*, James R. Wright (Missouri, Southern Illinois, Southern Indiana), Stephen E. Wright (Iowa, Nebraska, Kansas), 706 Chestnut St., Telephone Chestnut 1965.

New York 17, Richard Rimbach, Jr., 525 Lexington Ave., Rm. 359, Telephone Murray Hill 2-0821

Philadelphia, Robert H. Maxwell, 7 Wilde Ave., Drexel Hill, Pa., Telephone Clearbrook 9-4342 (Phila. Suburban).

Pittsburgh 12, C. Goldcamp, 921 Ridge Ave., Telephone Fairfax 1-0161

Dallas, Texas, Edward F. Wright (Oklahoma-Texas-Louisiana) 505 N. Ervay, Rm. 310. Telephone Prospect 0189

London. W.1, England. John C. N. Hughes, Crown House, 143-147 Regent St., Telephone Regent 3891

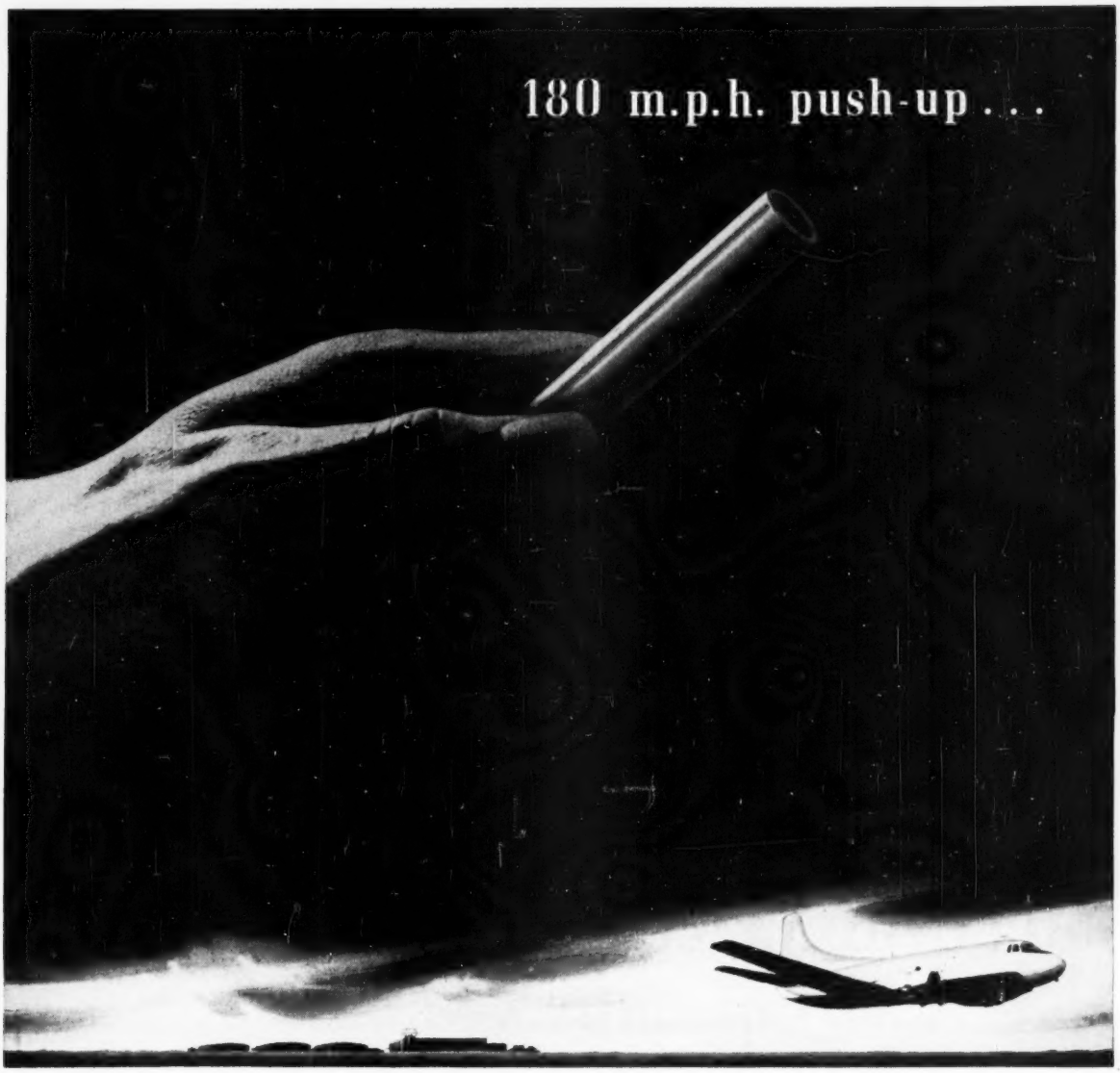
MEMBER ABC Audit Bureau of Circulation

SUBSCRIPTION RATES
For One and Two Years.
United States, U. S. Possessions, and Canada $4.00, $7.00.
Latin America and Australia $5.00, $8.00.
All other countries except those noted below $6.00, $10.00.

For the present, subscriptions not accepted from Austria, Bulgaria, China, Czechoslovakia, Eastern Zone Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia.

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.



Any time you fly in a Martin 4-0-4, Superior tubing is probably working for your safety.

Once you're airborne, watch the 840-pound main landing gear assemblies flip forward and up with amazing speed, even though they may be working against a 180 m.p.h. drag. Fast landing gear retraction gives you an extra margin of take-off safety because "clean" aircraft have better flight characteristics.

Chances are your Martin 4-0-4 contains many feet of Superior ½" stainless steel tubing. In the hydraulic system, this tubing operates at a pressure of 3000 p.s.i., normally. On Martin's torture racks, it has demonstrated remarkable endurance under violent pressure surges at 1000 cycles *per second*, even around minimum bends.

Performance like this may well have a bearing on your production problems as well as on your personal safety. Superior's long experience in fine tubing, backed by highly-developed production equipment and extensive research and testing facilities assures you of top-quality small tubing for doing tough jobs well. Outline your own production problems in a letter to us, right now—we'll send you complete information and the appropriate Data Memo by return mail. Address: Superior Tube Company, 1968 Germantown Ave., Norristown, Pennsylvania.

Round and Shaped Tubing available in Carbon, Alloy, and Stainless Steels, Nickel Alloys and Beryllium Copper.

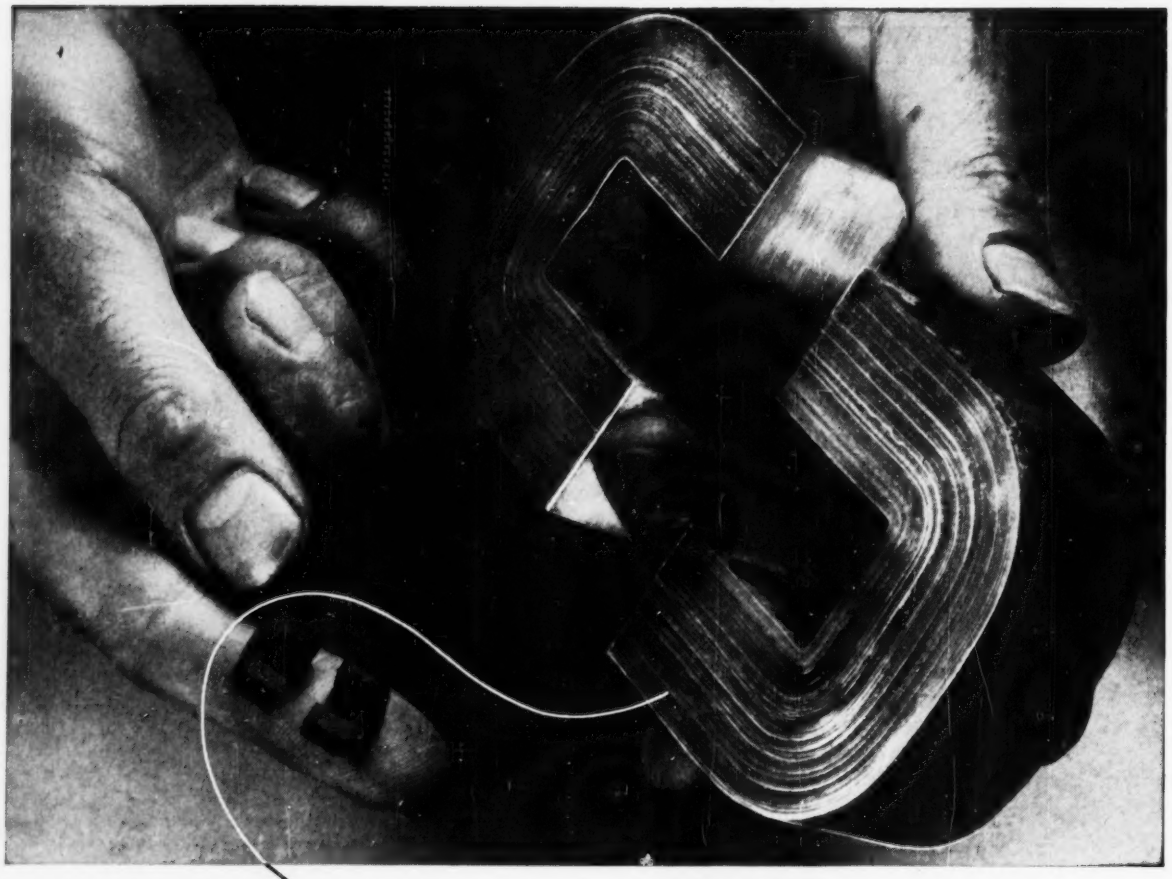
Superior

THE BIG NAME IN SMALL TUBING

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331

All analyses .010" to ⅜" O.D.
Certain analyses (.035" Max. wall) up to 1⅜" O.D.

For more information circle 6 on inquiry card.



SILECTRON C-CORES...BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

WAD 4363

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

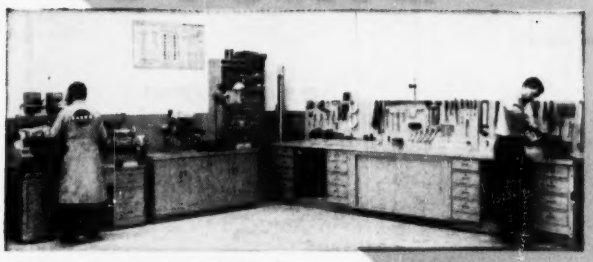
DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

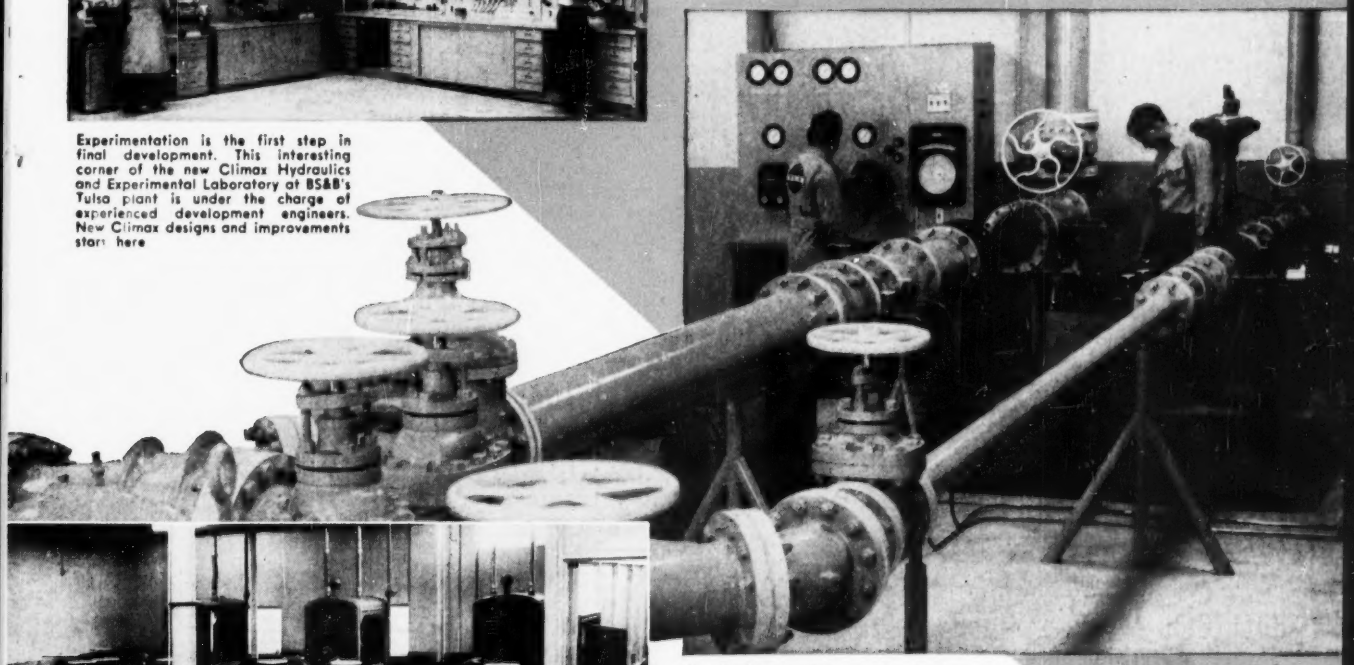
For more information circle **7** on inquiry card.

Testing the performance on which BS&B reputation has been built;

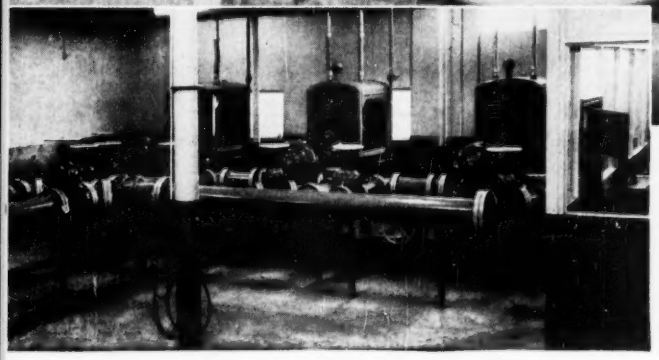
Pre-Proving CLIMAX CONTROLS to Insure On-The-Job Efficiency



Experimentation is the first step in final development. This interesting corner of the new Climax Hydraulics and Experimental Laboratory at BS&B's Tulsa plant is under the charge of experienced development engineers. New Climax designs and improvements start here



The finished control on the "torture rack." Meter runs flow test the valves up through 10". Strain gauge equipment analyzes forces and stress under performance. Control panel in background regulates engines driving the pumps and registers flow data for calculation.



Pump manifolding for the 3 engine-driven pumps which will deliver up to 4500 gallons per minute at a 100 lb. discharge for high volume tests. Pumps can also be manifolded for series operation, in which case 300 lbs. of water at 1500 gallons per minute can be delivered.

There's no question about a Climax Control giving the satisfactory service for which it is designed. That performance is tested and proven before the control goes into the field . . . checked for minimum and maximum capacity. Flow, flow effects, valve characteristics and strain results are all evaluated by experienced engineers. Through the new BS&B Climax Control Hydraulics laboratory come a continuing series of answers to the more efficient, safe and profitable application of automatic controls. One test suggests another, one application is adapted to a similar problem. The net result: Through research, better engineering, and accurate pre-testing, comes a more efficient Climax Control.

New Climax Controls Hydraulic and Experimental Laboratory

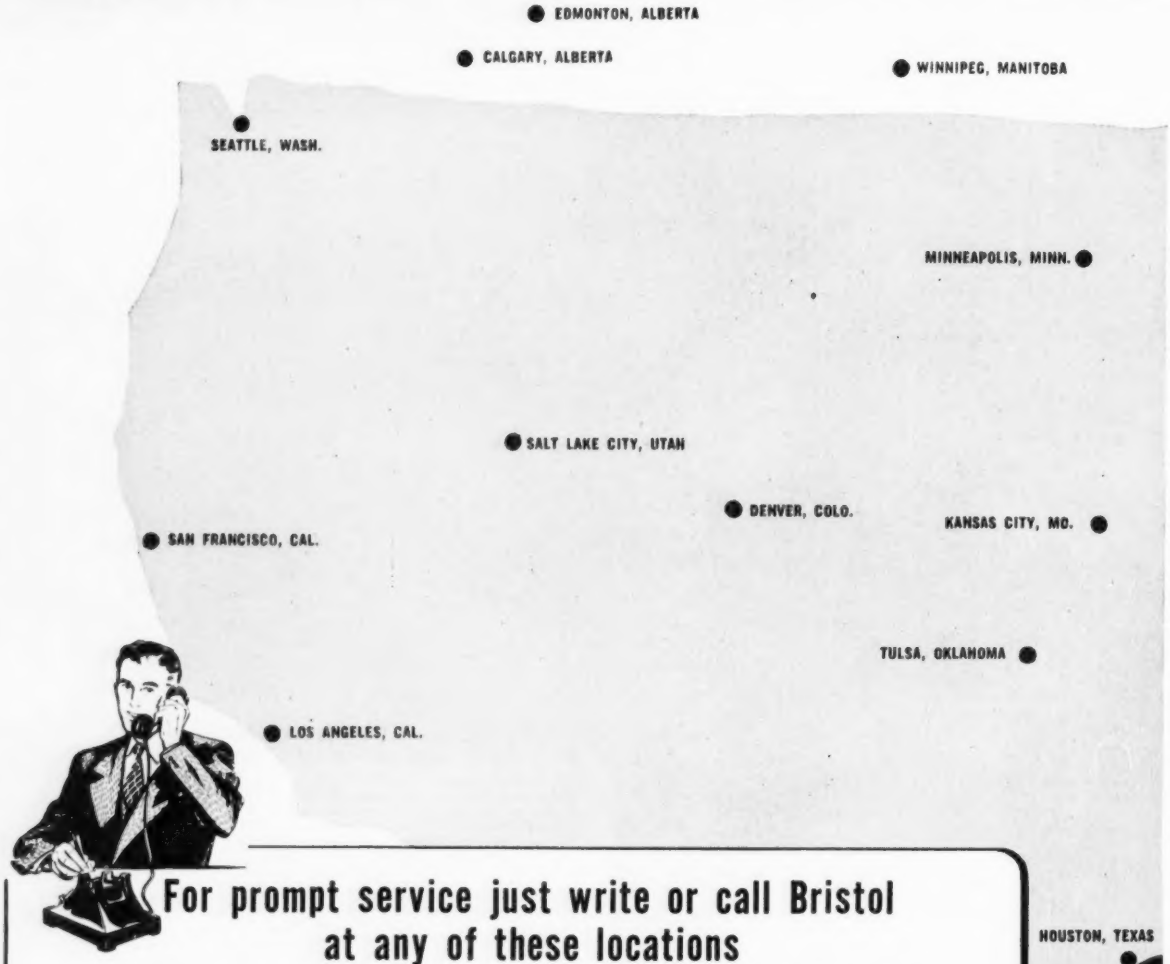
BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V12
7500 East 12th Street • Kansas City 26, Missouri

CLIMAX BS&B CONTROLS OUR 60TH YEAR

For more information circle 8 on inquiry card.

JUST PICK UP YOUR 'PHONE...
AND YOU'RE IN TOUCH WITH A BRISTOL



For prompt service just write or call Bristol at any of these locations

Birmingham 3, Ala.
324 Comer Bldg.
3-0034

Los Angeles 58, Cal.
2181 E. 25th St.
Kimball 4109

San Francisco 7, Cal.
40 Berry St.
Garfield 1-5462

Denver 4, Colo.
1236 Elati St.
Cherry 1505

Waterbury 20, Conn.
Bristol Rd.
6-4451

Atlanta 3, Ga.
231 Healey Bldg.
Walnut 7607

Chicago 11, Ill.
351-363 E. Ohio St.
Whitehall 4-2190

Indianapolis, Ind.
531 K. of P. Bldg.
Market 4194

Louisville, Ky.
512 Republic Bldg
Amherst 1818

New Orleans, La.
WX-2881

Baltimore 2, Md.
Room 501, Mathieson Bldg.
Saratoga 7-2427

Boston 16, Mass.
802 Statler Bldg.
Hubbard 2-1728

Detroit 21, Mich.
10329 W. McNichols Rd.
University 4-4284

Minneapolis 15, Minn.
P.O. Box 1101
Atlantic 0714

Kansas City, Mo.
300 Crawford Bldg.
Harrison 7301

St. Louis 2, Mo.
742 Cotton Belt Bldg.
Chestnut 7892

Buffalo 7, N. Y.
1807 Elmwood Ave.
Delaware 3754

New York 19, N. Y.
250 W. 57th St.
Circle 5-4953

Charlotte, N. C.
P. O. Box 3180
Phone 4-0050

Akron, Ohio
Enterprise 4146

Cincinnati 37, Ohio
1717 Section Road, Room C-4
Elmhurst 0328

Cleveland 2, Ohio
8905 Lake Ave.
Atlantic 1-6924

Tulsa 3, Oklahoma
1508 Thompson Bldg.
54-6468

Philadelphia 7, Pa.
Market St. Natl. Bank Bldg.
Rittenhouse 6-2386

Pittsburgh 12, Pa.
210 E. Parkway, N.S.
Fairfax 1-5190

Houston 19, Texas
1705 W. Gray Ave.
Linden 2881

Knoxville, Tennessee
P.O. Box 202
5-5992

Salt Lake City 1, Utah
208 South West Temple
22-5553

Seattle 1, Wash.
6626 White Bldg.
Elliot 3361

Washington, D. C.
Republic 7-0655

Milwaukee 2, Wisc.
735 N. Water St., Rm. 1327
Broadway 6-4393

CANADA

Calgary, Alberta
Gorman, Ltd.

Edmonton, Alberta
Gorman, Ltd.

Winnipeg, Manitoba
Filer-Smith Mach. Co., Ltd.

Halifax, Nova Scotia
A. R. Williams Mach. Co., Ltd.

Hamilton, Ont.
384 Emerald St., N.
2-0335

Toronto 2, Ont.
71-79 Duchess St.
Empire 3-3423

Montreal 2, Quebec
Dominion Sq. Bldg.
University 6-4725

For more information circle 9 on inquiry card.

Field Service Center

Wherever you are, from coast to coast, you're as close to your Bristol service center as you are to your telephone

When you buy Bristol instruments, you can get service when you want it — with no delays.

Our nation-wide staff of experienced, factory-trained service engineers is ready to give you personal assistance in servicing Bristol Automatic Controlling, Recording and Telemetering instruments. If you are any appreciable distance from a Bristol office, our serviceman can take the next plane.

Our periodic check-up service is designed to help users of Bristol instruments keep their equipment in top operating condition. In this plan, a Bristol Service Engineer calls at regular intervals to inspect and make any minor adjustments needed. Preventative measures like this save valuable production time by minimizing the chances of breakdowns at critical periods. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

4.1

Play it safe...for the finest in instruments and the finest in service— it's Bristol all the way.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 9 on inquiry card.

THREE BASIC REASONS

for using HAGAN
RING BALANCE
INSTRUMENTS

and HAGAN
AUTOMATIC COMBUSTION
CONTROLS

HAGAN
HALL
BUROMIN
CALGON

For more information circle **10** on inquiry card.

VERSATILITY

Hagan Ring Balance Instruments and Hagan Automatic Control units are the most versatile machines available for equivalent service today. Whatever your requirements may be, Hagan equipment can be selected to fit exactly your measuring, controlling, and recording or integrating problems.

DEPENDABILITY

An outstanding feature of Hagan Ring Balance Instruments and Hagan Automatic Controls has always been consistent dependability—with reliable performance throughout a long life, and with minimum maintenance costs.

ACCURACY

Maximum accuracy is designed and built into every Hagan Ring Balance Instrument and Hagan Automatic Control unit. This assures high operating efficiency for your plant, and savings which usually amount to many times the cost of the equipment.

Whatever your control or instrumentation problems, let Hagan engineers help you solve them. Their experience, gathered from thousands of successful installations, is at your service.

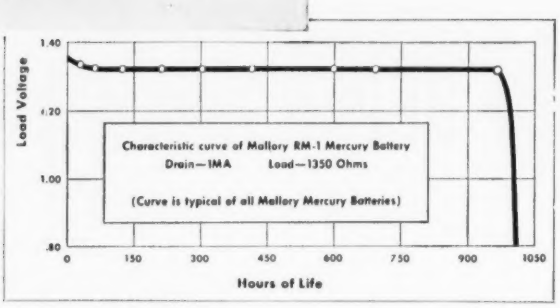
Hagan Corporation

HAGAN BUILDING PITTSBURGH 30, PENNSYLVANIA

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING FACILITIES

For more information circle **10** on inquiry card.

For Constant Voltages... Use Mallory Mercury Batteries



The constant discharge voltages shown in the curves are characteristic of the uniform, dependable power delivered by Mallory Mercury Batteries. This is especially important in mobile communications equipment, hearing aids, delicate optical equipment and many kinds of instruments in which constant discharge voltages are imperative for best performance.

This is only one advantage of Mallory Mercury Batteries, however. They operate dependably at microamperes or drains of 50 amperes... intermittently or continuously... always providing a dependable, uniform source of power—even after long periods of storage.

If these characteristics will improve the operation of your equipment, then let us send you complete information. Multi-cell battery stacks and packs can be designed to fit your exact needs.

Use Mallory Mercury Batteries for applications where:

- Constant voltage or current is required
- Size and weight are important
- Long storage periods are involved
- Battery leakage cannot be tolerated
- Wide temperature and pressure ranges are encountered
- Severe impact and shock is expected

For Transistor Applications

Mallory Mercury Batteries are especially suited for transistor applications ... where constant voltage and constant current are required.

P.R. MALLORY & CO. Inc.

MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., BATTERY DIVISION, NORTH TARRYTOWN, N.Y.

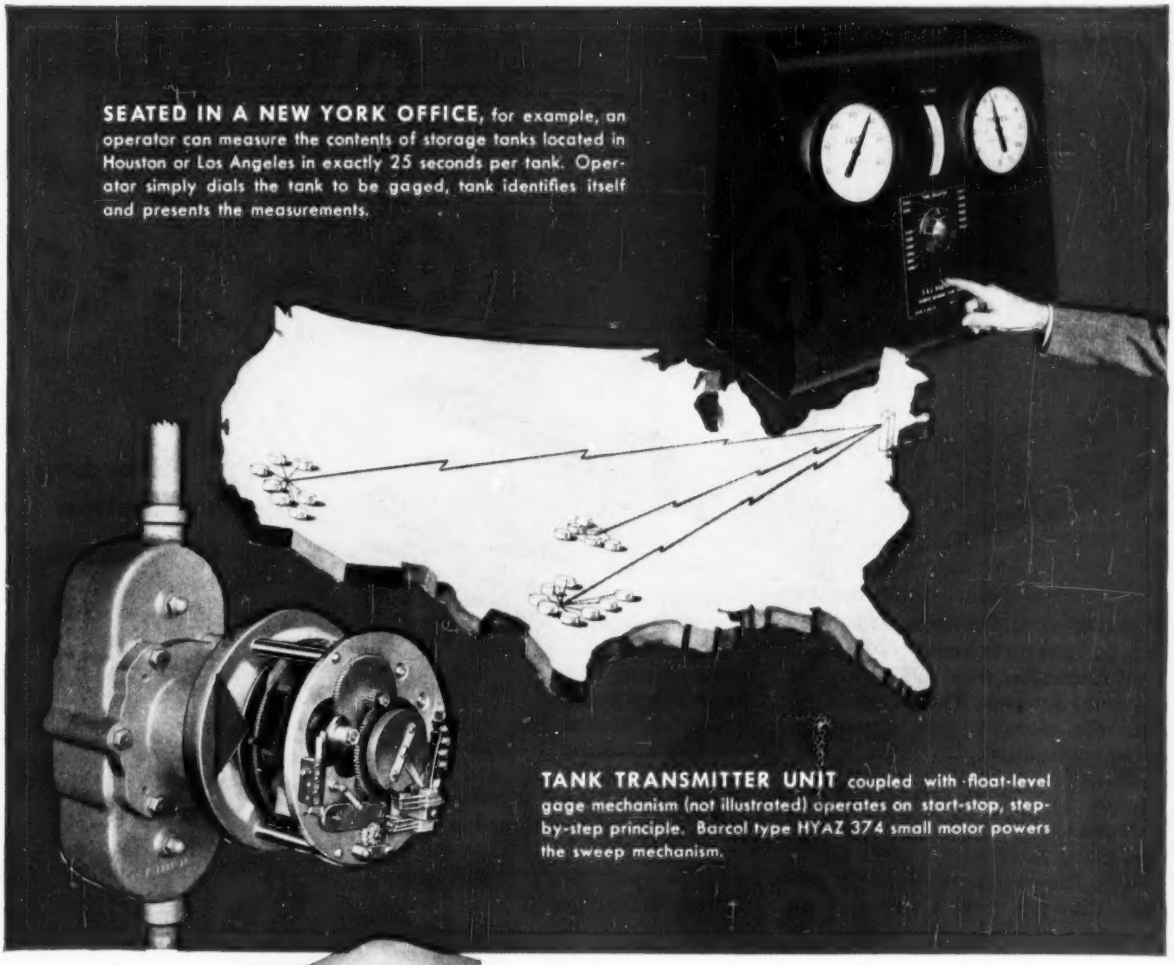
For more information circle **11** on inquiry card.

BARBER COLMAN

Barcol. Small Motors

chosen by Shand and Jurs Co. for their Varioplex System of Remote Level Gaging

Pioneers in automatic tank gaging for the petroleum industry, Shand and Jurs Co. of Berkeley, California, has now perfected a remarkable new remote system. Incorporating equipment of both the telegraph and dial telephone, this new Varioplex system indicates liquid levels quickly and accurately, regardless of whether the distance between the gaging station and the storage tanks is a matter of only a few miles or thousands! Powering the sweep mechanism in the tank transmitter unit is a standard Barcol type HYAZ 374 geared head motor. "Plus" features of this Barcol motor include rugged, precision-built gear train . . . porous bronze bearings . . . hardened and ground stainless steel shafts . . . high starting torque. This Varioplex application is another example of how Barber-Colman engineers can help in solving a design-production problem with the *exact* motor for the job.



SEATED IN A NEW YORK OFFICE, for example, an operator can measure the contents of storage tanks located in Houston or Los Angeles in exactly 25 seconds per tank. Operator simply dials the tank to be gaged, tank identifies itself and presents the measurements.

TANK TRANSMITTER UNIT coupled with float-level gage mechanism (not illustrated) operates on start-stop, step-by-step principle. Barcol type HYAZ 374 small motor powers the sweep mechanism.

In addition to type HYAZ shown at left, the Barcol line includes various other models of unidirectional, synchronous, and reversible motors—up to 1/30 h.p. With and without reduction gearing—open or enclosed types. Expert engineering service available. Write today, tell us your problem, ask for free data sheets on types of small motors needed for your applications.

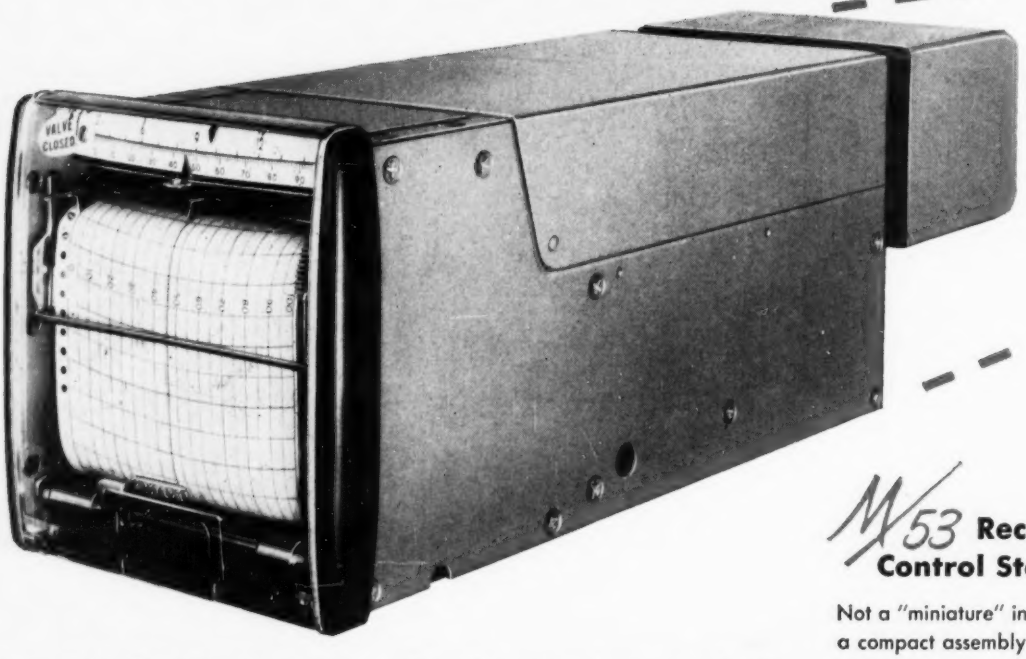
BARBER-COLMAN COMPANY, DEPT. L, 1215 ROCK ST., ROCKFORD, ILL.

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls • Air Distribution Products • OVERdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **12** on inquiry card.

This exclusive Foxboro

outperforms any other Automatic Controller!



If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller with M/53 Recorder on your process. The tougher the job, the more it will outperform other controllers!

Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this Foxboro component system has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

This Consotrol Controller-Recorder system is an entirely different and original concept of instrumentation, developed through knowledge gained in Foxboro's 30 years of control leadership. The exclusive floating disc live-balance controller, and the full size 4"-chart recorder, are combined in an ultra-compact yet fully accessible 6" x 6" assembly. The result is unequalled ease of operation, repeatability of action, and uniform product quality.

Get complete facts on this remarkable advance in automatic control. Write for Bulletin 463, and ask your Foxboro representative for a demonstration.

*Reg. U. S. Pat. Off

M/53 Recording Control Station

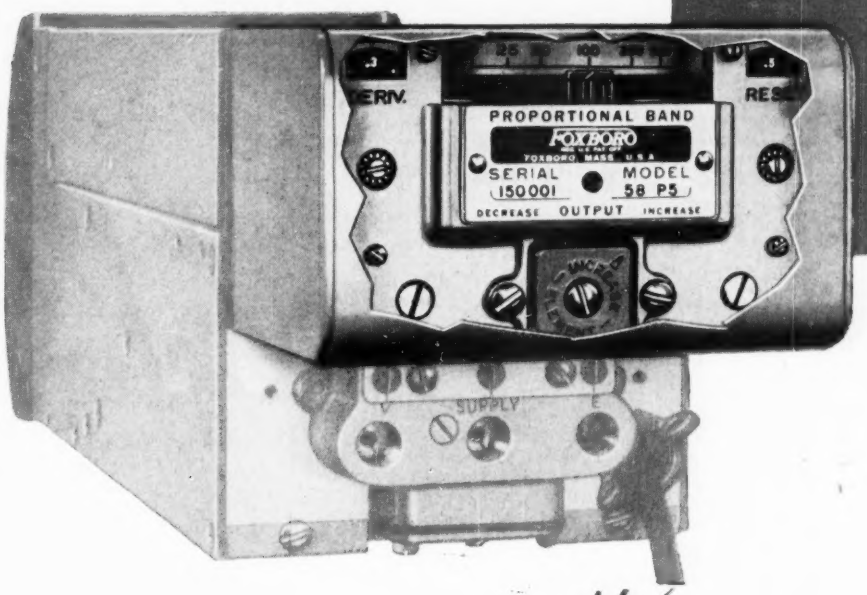
Not a "miniature" instrument, but a compact assembly of full-size component parts with no compromise in accuracy or convenience. *Features:* continuous valve position indicator . . . fast, no-drift control point setting plus micrometer adjustment . . . no external knobs . . . full 4" width, 30-day, easy-loading chart . . . several months' ink supply . . . single-switch automatic-manual transfer . . . additional measurement pen optional.

THE FOXBORO COMPANY, 4612 NEPONSET AVE., FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

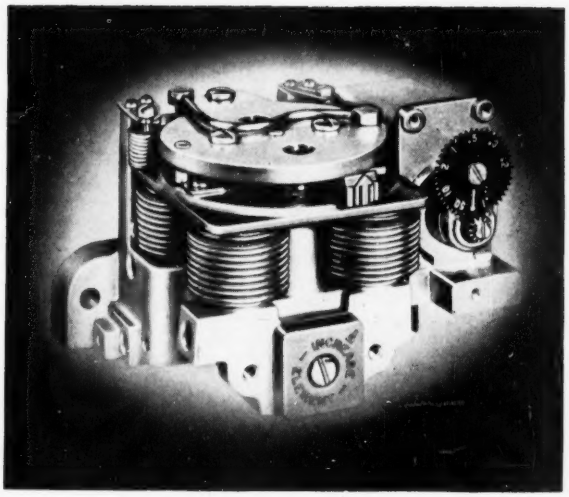
For more information circle **13** on inquiry card.

development



M/58 Controller

A remarkable design achievement, embodying the precision, sensitivity, and "live balance" of the exclusive floating disc. *Features:* no diaphragms . . . only one nozzle . . . only 19 parts . . . all four control functions available, including two ranges of reset . . . plug-in reset and derivative units. Can be integrally mounted with the M/53 as shown, or remotely located.



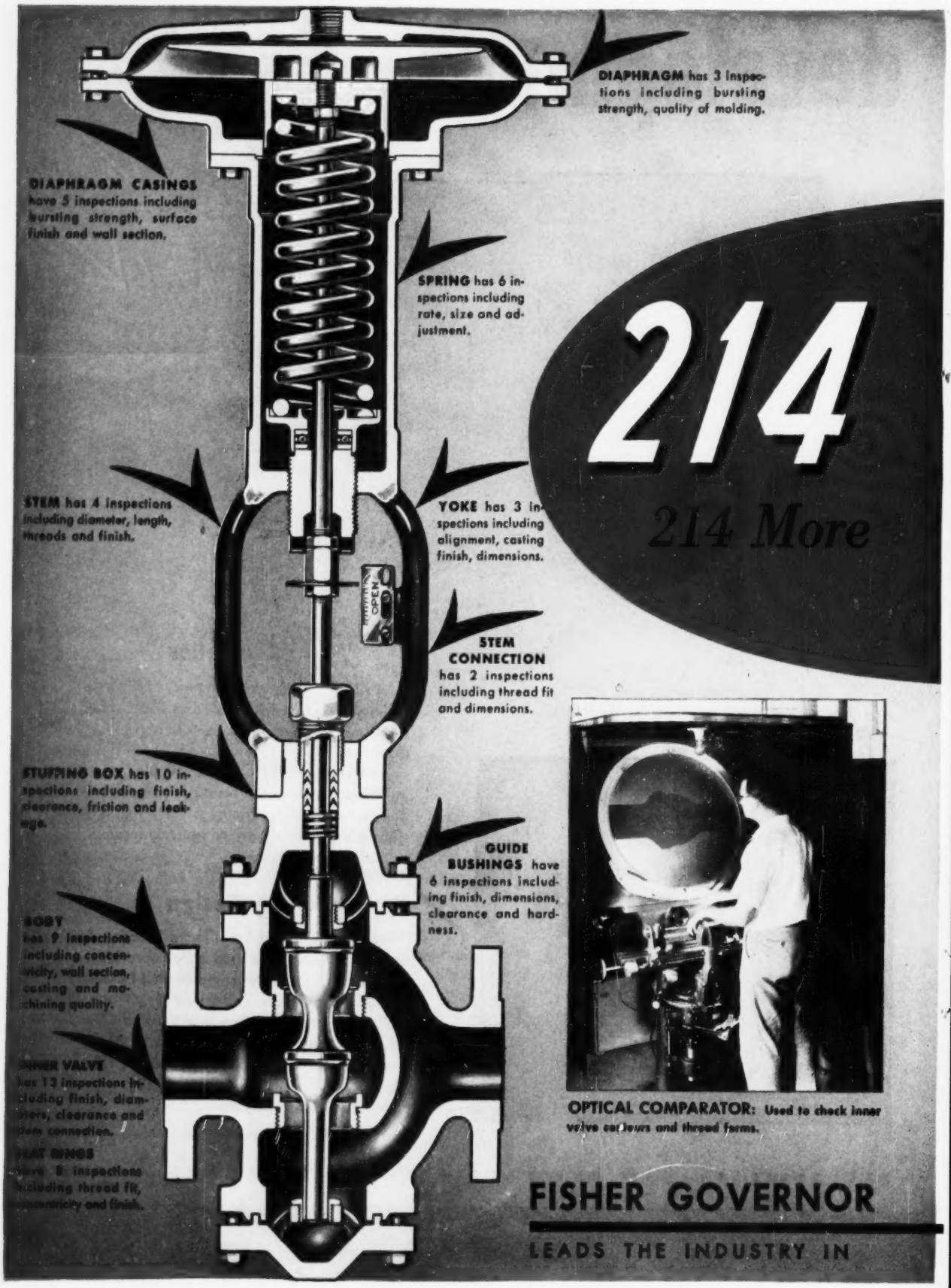
Revolutionary Design

Here's the high-precision Foxboro "floating disc" balancing system. Matched bellows provide stability and simplicity unapproached by other designs. Plug-in reset unit shown at right of assembly; derivative unit similarly plugs in at left. The lever-set proportional band adjustment is calibrated to 500%. This flexibility of function makes the M/58 adaptable to any process.

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

CONSOTROL INSTRUMENTS

For more information circle **13** on inquiry card.


DIAPHRAGM has 3 inspections including bursting strength, quality of molding.
DIAPHRAGM CASINGS have 5 inspections including bursting strength, surface finish and wall section.
SPRING has 6 inspections including rate, size and adjustment.
214
214 More
STEM has 4 inspections including diameter, length, threads and finish.
YOKE has 3 inspections including alignment, casting finish, dimensions.
OPEN
STEM CONNECTION has 2 inspections including thread fit and dimensions.
STUFFING BOX has 10 inspections including finish, clearance, friction and leakage.
GUIDE BUSHINGS have 6 inspections including finish, dimensions, clearance and hardness.
BODY has 9 inspections including concentricity, wall section, casting and machining quality.
INNER VALVE has 13 inspections including finish, diameters, clearance and stem connection.
SEAT RINGS have 8 inspections including thread fit, concentricity and finish.
OPTICAL COMPARATOR: Used to check inner valve contours and thread forms.
FISHER GOVERNOR
LEADS THE INDUSTRY IN

For more information circle **14** on inquiry card.

QUALITY CONTROL

FISHER®

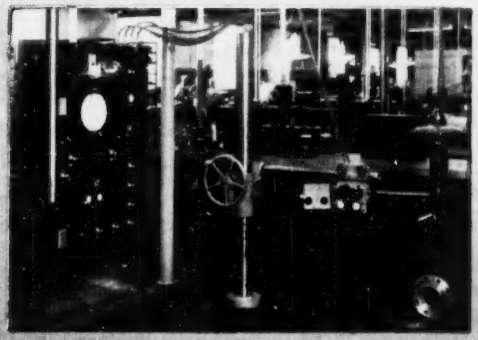
Inspections

Reasons WHY FISHER GIVES YOU MORE FOR YOUR MONEY!

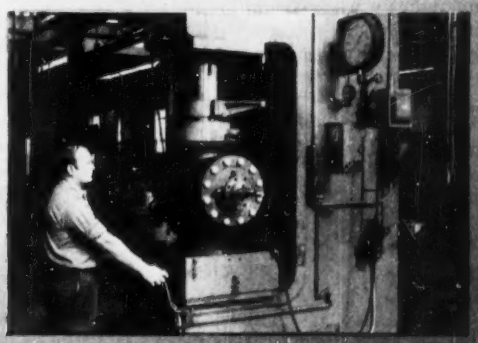
Automatic Controllers

Pressure Regulators — Pump Governors — Liquid Level Controllers — Pilot Operated Regulators — Lever and Float Valves — Intermitters — Gas Regulators — Valve Positioners

Here at Fisher we believe that *inspection makes perfect.* That's why *every* Fisher Automatic Controller is subjected to an *expert* and *comprehensive* inspection procedure. Typical of this rigid quality control program is the inspection schedule of the Fisher Type 57T diaphragm motor valve illustrated, with a few of the more prominent inspections indicated. From "start to finish", a total of *214 inspections* assures *long trouble-free service* in meeting the most exacting operating requirements. Yes, this Fisher *insistence on perfection* is another example of why Fisher Automatic Controllers always give you *more for your money!*



HYSTERESIS TEST PANEL:
To detect misalignment, friction and check range of operation. Certified test certificates on specification.



HYDROSTATIC TESTING MACHINE:
Hydraulic pressure testing procedure for casting soundness, as prescribed by ASA.

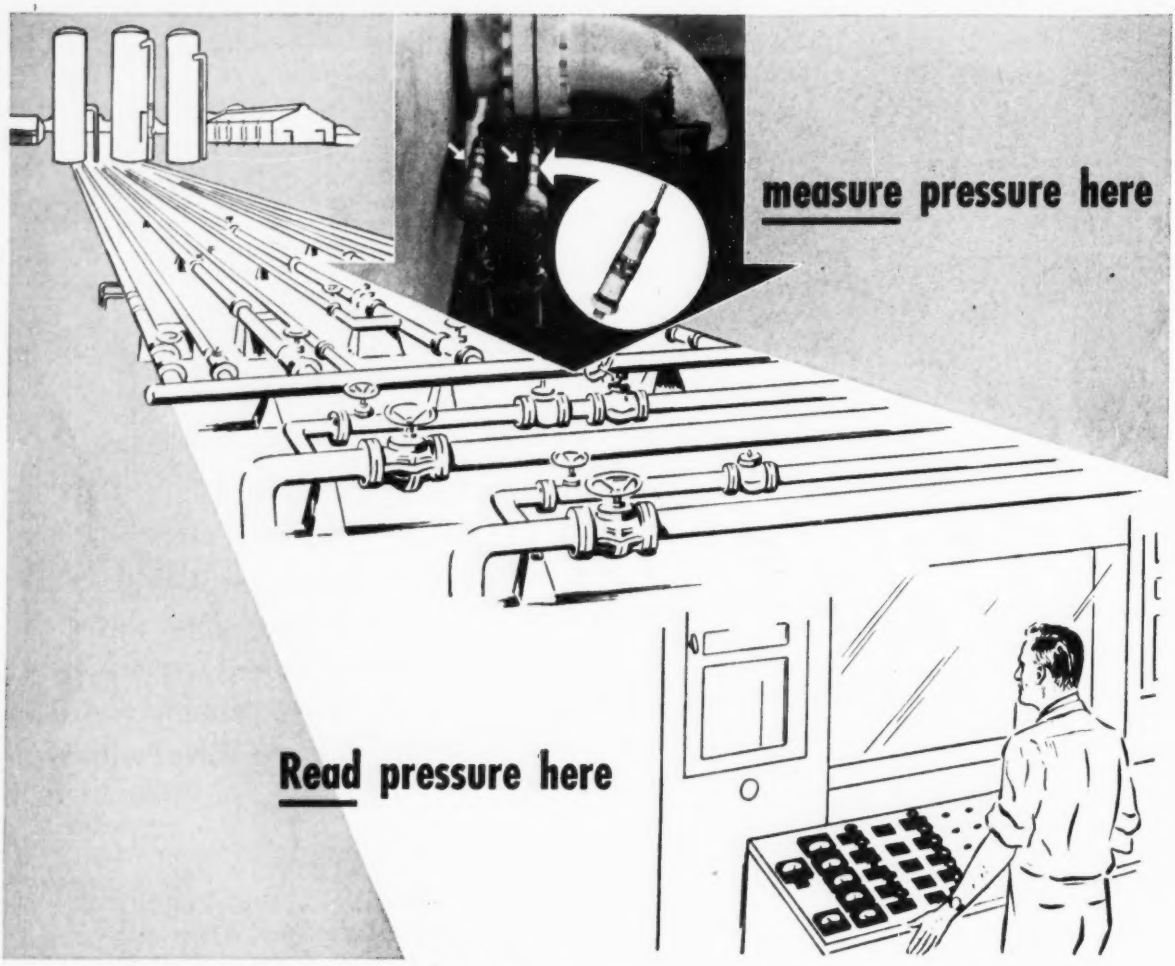
COMPANY • Marshalltown, Iowa

RESEARCH FOR BETTER PRESSURE CONTROL

FISHER

Since 1880

For more information circle **14** on inquiry card.



SR-4® Devices in industry... uses unlimited

THE PLANTATION PIPELINE PROBLEM:

Plantation sought a method of remote pipe line pressure control which would eliminate their calibration, maintenance and fire problems.

THE BALDWIN SOLUTION:

After a year's experience with an experimental installation Plantation installed 24 completely electronic remote indicating systems incorporating nearly 200 Baldwin SR-4 pressure cells.

Plantation reports that their SR-4 Pressure Measuring systems, in operation for a year at all 12 dual line pumping stations between Baton Rouge, La. and Charlotte, N.C., have required virtually no maintenance and have greatly reduced personnel required for maintenance of equipment and calibration of instruments. There are five reasons why the SR-4 system is so economical for pipe line control.

1. It is more accurate. Capacities of the cells range up to 1500 psi and the overall accuracy is 1% of full scale.

2. It remains accurate. After a full year's service the SR-4 pressure cells agreed with original factory calibrations within 0.2%.

3. By eliminating small fluid control piping containing inflammable product, the SR-4 system avoids potential fire and explosion hazards.

4. Ruggedly constructed, hermetically sealed, and with no moving parts, the SR-4 pressure cells make Plantation's sensing system virtually free of maintenance costs.

5. Highly engineered Baldwin electronic instrumentation has permanent accuracy, negligible maintenance.

It will pay you to investigate the *unlimited uses* for Baldwin SR-4 Devices. For example, in addition to pressure measurement on pipe lines, SR-4 Pressure Cells can depth gage storage tanks or measure ultra-high pressures, surges and explosion waves. For complete information about these uses as well as a multitude of SR-4 applications in measuring torque and load, *write* Dept. 3115, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON

Philadelphia 42, Pa. • Offices in Principal Cities • In Canada, Peacock Bros., Ltd., Montreal, Quebec

For more information circle **15** on inquiry card.

free . . .

to men with instrumentation headaches

These 3 Fielden Bulletins Show You . . .

- How to save on original cost and maintenance of measuring, recording and controlling instruments.
- How to get all the instrument accuracy you need without paying for marginal precision.
- How to get dependable level control or indication of liquids, granular solids, viscous fluids and powders.

TEKTOR ELECTRONIC LEVEL CONTROL

Low cost, accurate level-limit control or indication of *nearly any substance that moves*. Simple to install—easy to adjust—foolproof in operation.

TEKTOLOG ELECTRONIC RECORDER

Accurate to ±1% of full scale or better—yet low in price because of simplified design and construction. Only 4 principal units—easily accessible. Easy installation. Minimum maintenance.

TELSTOR ELECTRONIC LEVEL INDICATOR

Trouble-free, inexpensive gauging of liquids or divided solids. No moving parts. No floats to stick or leak. No pneumatic or hydraulic piping to clog or leak. Gives accurate readings at remote stations. Easily installed. Easily serviced.

ALL FIELDEN ELECTRONIC INSTRUMENTS are designed and constructed in accordance with our new concept of simplified instrumentation. Result:—Rather surprising savings with no sacrifice of essential accuracy.

CHECK AND MAIL COUPON TODAY

☐ TEKTOLOG Recorder ☐ TELSTOR Indicator ☐ TEKTOR Control

Fielden
INSTRUMENT DIVISION
ROBERTSHAW-FULTON CONTROLS COMPANY
2920 N. 4th St., Dept. A Philadelphia 33, Pa.
Dollar for Dollar—Your Best Instrument Value

Send me Technical Bulletins checked at left. No obligation.

*Name*_____

*Title*_____

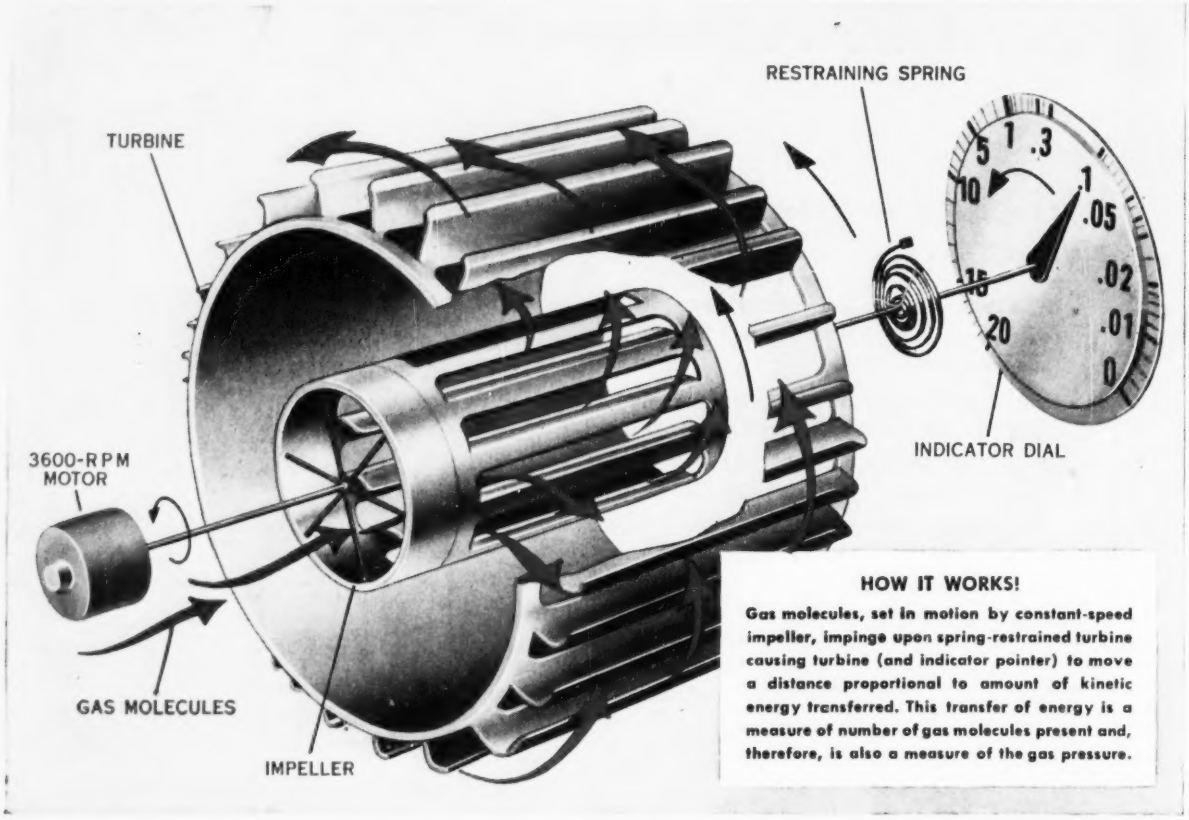
*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*____

For more information circle **16** on inquiry card.

LABORATORY INSTRUMENTS


RESTRAINING SPRING
TURBINE
5 1 .3
10
1
.05
.02
.01
0
20
INDICATOR DIAL
3600-RPM MOTOR
GAS MOLECULES
IMPELLER
HOW IT WORKS!
Gas molecules, set in motion by constant-speed impeller, impinge upon spring-restrained turbine causing turbine (and indicator pointer) to move a distance proportional to amount of kinetic energy transferred. This transfer of energy is a measure of number of gas molecules present and, therefore, is also a measure of the gas pressure.

FOR SIMPLIFIED VACUUM MEASUREMENT—EASY OPERATION—EASY INSTALLATION . . .

G.E. Announces Revolutionary New Molecular Vacuum Gage

Similar to a "fluid clutch" in principle of operation, this new entirely mechanical molecular vacuum gage overcomes many of the problems encountered in the use of other type vacuum gages.

NO PRIMARY ELEMENT TO BURN OUT

Having no electronic tubes or other electrical detecting devices, the new G-E molecular vacuum gage assures continuous operation without time-consuming delays caused by electrical failure such as tube burnout.

New G-E gage is easy to mount, and its small size requires but a minimum of panel space.

UNHARMED BY ATMOSPHERIC PRESSURE

Because this new device may be opened to atmospheric pressure suddenly without damage to the instrument, it is especially valuable where personnel may be untrained in the use of complicated instruments.

SIMPLIFIED OPERATION

The new G-E molecular vacuum gage requires no complicated setting of control knobs. Direct-reading, the instrument calibration remains unaltered through continuous operation. The long-scale span in the high-vacuum range, and the easy-to-read indicator dial assure accurate readings.

HIGHLY VERSATILE

Available in two types, the molecular vacuum gage is supplied with a scale for the direct reading of dry air, or with a linear scale which may be calibrated for other gases. It is therefore suitable for laboratory and research installations as well as for many manufacturing and chemical processes. Price of the complete unit is $193.00.* For further information check coupon for Bulletin GEC-986.

For more information circle **17** on inquiry card.

FOR PRECISION MEASUREMENT

Costly Production Problems Easily Solved with the use of General Electric Oscillograph

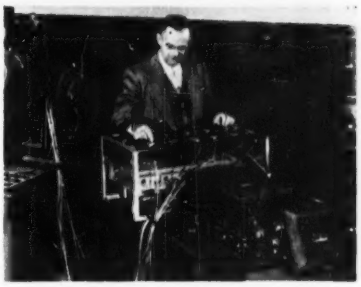
The United Shoe Machinery Corporation's research division gets the answers to timing and strain design problems by using General Electric PM-10 oscillographs.

PM-10 USED WITH STRAIN GAGES

A lever and cam system on their new Welt Butting and Tacking Machine, Model B, was breaking and causing high maintenance expense. In order to find the cause of the trouble, a six channel a-c strain gage amplifier was used in conjunction with a PM-10 oscillograph to record the strains while the machine was operating normally. The answers obtained enabled USMC engineers to quickly solve this important field service problem.

RECORDS MANY QUANTITIES

Designed to meet the wide field of applications for a twelve-element oscillograph, the Type PM-10 can be used to make simultaneous records of voltage, current, time, pressure, speed, stress, strain, sound, and vibration. Viewing while a record is being made is possible. Timing lines can be recorded directly on the film. Prices start at $4000.00* for the complete equipment. For more information check coupon for Bulletin GEC-449



Studies with Type PM-10 oscillograph at United Shoe Machinery Corporation resulted in substantial savings in maintenance costs.

General Electric Oscillograph Aids Relay Manufacturer in Developmental Testing

Oscillograms in one minute was the answer recently when a large electrical manufacturer found it necessary to make some rapid development tests on a new type relay. The General Electric PM-18 oscillograph, equipped with a Polaroid-Land film holder, enabled the manufacturer to obtain permanent records of each test one minute after test, and to complete an entire series of eight tests in one hour.

Polaroid-Land film holder makes possible permanent records of each test with PM-18.

HIGH SENSITIVITY

The General Electric PM-18 oscillograph features a variety of highly sensitive galvanometers and adjustable time sweep of 0.1 to 0.5 seconds.

4 SIMULTANEOUS RECORDS

Designed to record two, three, or four currents or voltages simultaneously, the PM-18 can be used for sine-wave frequencies up to 500 cycles per second with its Polaroid-Land film holder and up to 2000 cycles per second with the continuous-drive film-holder attachment.

EASILY PORTABLE

Weighing only 30 pounds, the PM-18 can be readily carried to where it is needed. It is not necessary to bring the job to the oscillograph.

LOW COST

The General Electric PM-18 oscillograph, complete with Polaroid-Land film holder and two galvanometers costs only $850.59.* Check coupon for free Bulletin, GEC-580.

* Manufacturer's suggested retail price.

You can put your confidence in—

GENERAL ELECTRIC

NEW...

1953 CATALOG

G-E Measuring Equipment

64 pages describing all of General Electric's testing and measuring devices. For free copy check GEC-1016A in coupon.

SECTION B605-56, GENERAL ELECTRIC, SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Measuring Equipment Cat.(GEC-1016A)
- ☐ Molecular Vacuum Gage (GEC-986)
- ☐ Type PM-10 Oscillograph (GEC-449)
- ☐ Type PM-18 Oscillograph (GEC-580)

NAME .....

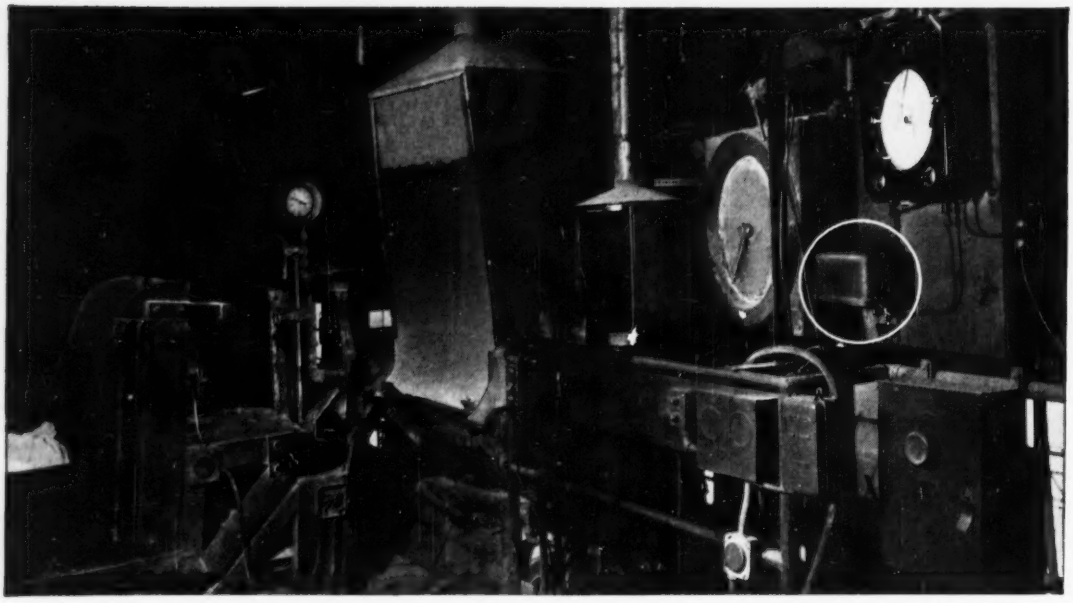
COMPANY .....

STREET .....

CITY ..... ZONE ... STATE ....

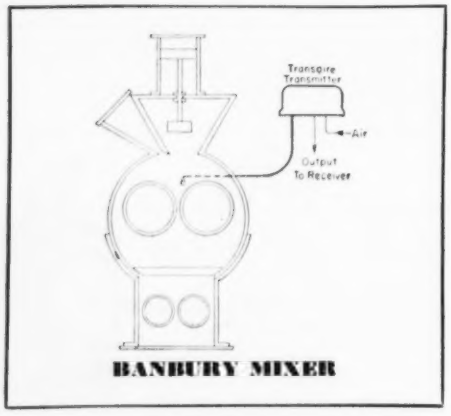
For more information circle **17** on inquiry card.

To measure *dynamic*



Accurate measurement of dynamic temperatures in Banbury Mixer has made automatic control feasible and profitable.

HERE ARE FOUR TOUGH MEASUREMENT



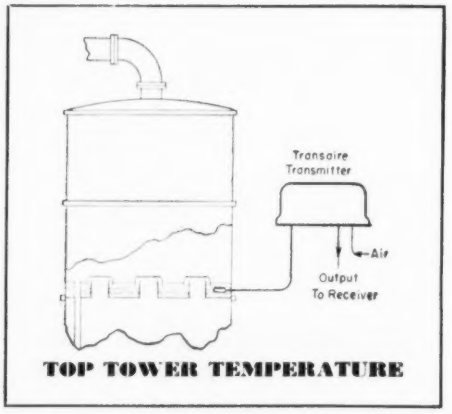
BANBURY MIXER

Compensates for Poor Heat Transfer of Mix

Problem: Poor heat transfer of the rubber compounds in a Banbury Mixer makes it difficult to closely measure the mechanical heat generated. Excessive heat causes deterioration of ingredients—and a very real fire hazard.

Solution: TRANSAIRE Temperature Transmitter, with derivative action (SPEED-ACT) in the measuring system, compensate for both the poor heat conductivity of the mix and the inherent thermal lag of the rugged separable well required. The cigarette-size bulb permits its ideal location, and aids the speed of response, as of course does the THERMOSPEED sleeve in the separable well.

Results: An accurate record of the true *dynamic temperatures* of the mix and the *time* of every batch. Another dividend: the process can now be put under automatic control (see photograph above)—never before feasible.



TOP TOWER TEMPERATURE

Short Range Span Detects Temperature Trends

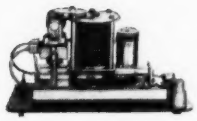
Problem: To get highest possible purity of product consistent with good production economy. This requires the quick detection of temperature trends over a very narrow range.

Solution: The short, shiftable range spans (as short as 50°F.) for the TRANSAIRE Temperature Transmitter permit selection of operating range by a simple screwdriver adjustment. SPEED-ACT feature assures detection of temperature change of less than 1/10 of 1% of span and is accurate to ½% of span.

Results: Close control because the minute temperature trends are practically instantaneously detected and transmitted to the controller and receiver. This means higher yield of a purer product, also great flexibility in changing to different product requirements.

For more information circle **18** on inquiry card.

temperatures you need
DYNAMIC ACCURACY



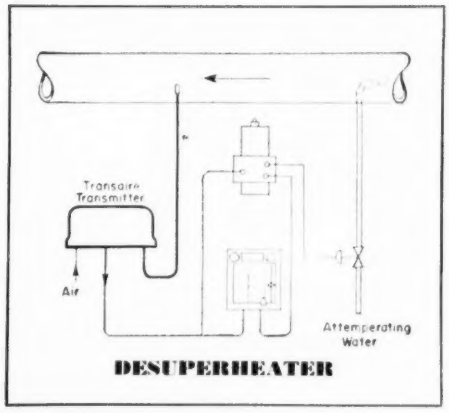
Dynamic Accuracy, (the accuracy of an instrument in measuring changing or *dynamic* conditions), reaches a new high in the Taylor TRANSAIRE* Temperature Transmitter. This instrument solves the problem of many process engineers who realize that an instrument, accurate to a fraction of a degree in measuring static conditions, can easily be in error by a great many degrees when the temperature is changing. It operates on the force-balance principle, pneumatically transmitting temperature as far as 1000 ft. with an extremely high degree of accuracy. And its standard output pressure range of 3-15 psi means that no special calibration of receivers is necessary.

This ability to accurately measure changing temperature is due to the low heat capacity of the cigarette-size bulb and dynamic compensation, i.e. compensation for inherent lags both in the measuring system and in the rate of heat transfer of the process medium. It is achieved by the introduction of derivative action (SPEED-ACT*) in the measuring circuit.

Not only does this new accuracy reveal previously unknown temperature conditions in a process, but this hitherto unattainable speed of response has a profound effect on the results obtainable when temperature is automatically controlled.

Ask your Taylor Field Engineer or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

PROBLEMS SOLVED BY DYNAMIC ACCURACY



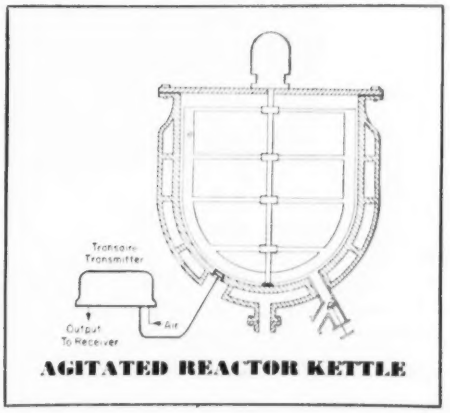
DESUPERHEATER

Fast Speed of Response Catches Rapid Temperature Changes

Problem: Steam at high temperature, as with any gas temperature measuring problem, has poor heat transfer characteristics, making it difficult to measure dynamic temperatures.

Solution: The low heat capacity of the cigarette-size bulb (made possible by the force-balance system), and SPEED-ACT compentsation for the rugged well required, give unprecedented speed of response to temperature changes under these adverse conditions.

Results: Smooth efficient operation, and greater protection to expensive equipment in subsequent processing steps.



AGITATED REACTOR KETTLE

Small, Flat, Flush Bulb Clears Scraper

Problem: Close temperature measurement and control in a jacketed vessel, requiring scraping agitation, for which conventional measuring devices have proven impractical.

Solution: Small, flat temperature sensitive bulb installed flush with the inside wall of the vessel. SPEED-ACT derivative action in the measuring system to compensate for poor heat transfer.

Results: Closer temperature measurement and control; the use of standard agitating equipment without modification; uniformly high yield in all kettle areas — the difference between satisfactory and unsatisfactory operation.

*Trade-Mark

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

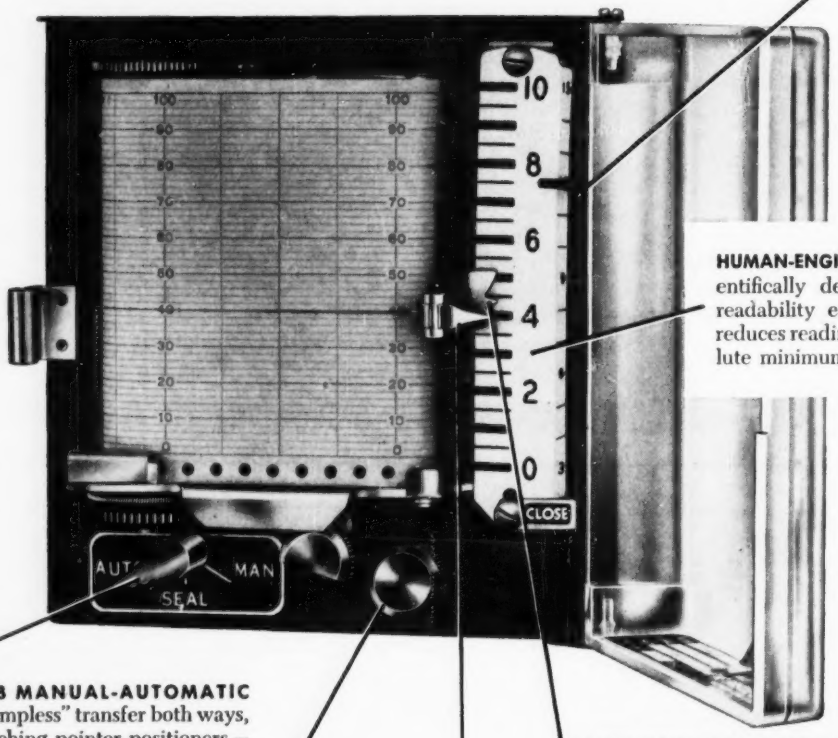
For more information circle **18** on inquiry card.

WHAT'S NEW AT BRISTOL . . . .

BRISTOL'S METAGRAPHIC* RECORDERS

with CONTINUOUS VALVE-POSITION INDICATION

*** Separate from set-point indication * Gives continuous data on control valve position and level of process operation * No switching to get reading**



HUMAN-ENGINEERED SCALE, scientifically designed for instant readability even at a distance, reduces reading errors to an absolute minimum.

SINGLE-KNOB MANUAL-AUTOMATIC TRANSFER. "Bumpless" transfer both ways, simply by matching pointer positioners — no need to read actual scale values — minimizes reading errors — speeds operation.

CONTINUOUS SET-POINT INDICATION. Shape and color of set-point target make it easy to see at a glance when process is on or off the control point. Rapid scan deviation indicator.

SET-POINT REGULATOR. High-precision, two-stage, no-drift regulator — high capacity (3 scfm) output for fast manual control in emergencies.

CONTROL VARIABLE RECORDED AND INDICATED. High-visibility pointer (fluorescent paint) for accurate reading at a distance.

*** Bristol *Metagraphic* Pneumatic Transmission Instruments measure, indicate, record, and control pressure, temperature, vacuum, flow, differential pressure and liquid level. Write for bulletin. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.**

4.6

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **19** on inquiry card.

a valve that never blows its top

All K & M diaphragm Control Valves have a drawn steel diaphragm casing able to withstand extreme heat, impact, pressure and shock . . . and a cast steel open yoke that retains its strength when the heat is on. When something goes wrong, the difference between safety and danger might very well be this all steel construction.

Further, consider the everyday advantages of the all steel K & M construction: One man can move the smaller size valves without hoists, for the K & M steel topworks weighs only half as much as other topworks of equal size. The open yoke, provided in cast steel by *only* K & M, assures accessibility and completely eliminates any possible accumulation of gas, vapor or condensate.

More linear . . . more accurate . . . more responsive

The K & M molded neoprene diaphragm provides a large effective area which is constant throughout the long stem travel. Thus, K & M Diaphragm Motors provide maximum linearity in stem movement and virtually the highest power factor available. Operating with high capacity, low turbulence K & M valve bodies, these motors mean more accurate, more responsive flow regulation.

For Complete Automatic Control Valve Data: **Write for your copy of the new K & M Valve Engineering Data Catalog, Bulletin CV53.** ***Also Available . . .*** **New Valve Size Calculator with Low Flow Data.**

K&M

diaphragm control valves

KIELEY & MUELLER, INC.

Valve Makers
Since 1879

64 Genung Street
Middletown, New York

For more information circle **20** on inquiry card.

BIG SCOREBOARD

for Scores of Manufacturing Processes

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

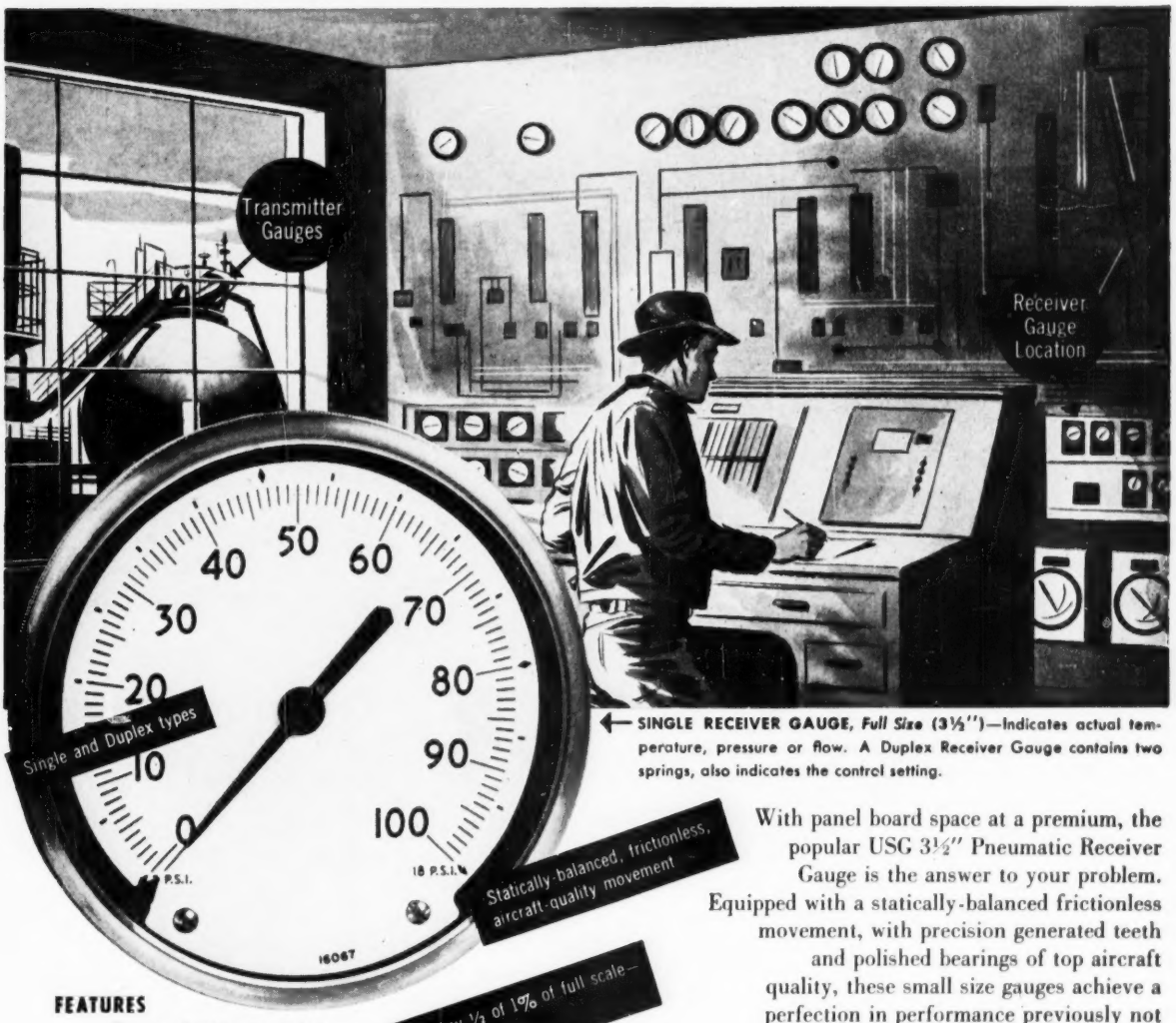
This husky long-lived Box-type Counter is available with 6 figures, in either the ratchet model, or in the new *geared* model with bearing inserts. This new gearing permits speeds of 1,000 counts per minute, which makes the counter adaptable to practically any manufacturing process where large figures are wanted for easy reading at a distance. Figure out how this counter can be *built into* your product as a new sales advantage over competition. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

For more information circle **21** on inquiry card.

Read pressure, temperature or flow at a distance with USG Pneumatic Receiver Gauges



← **SINGLE RECEIVER GAUGE, *Full Size* (3½")**—Indicates actual temperature, pressure or flow. A Duplex Receiver Gauge contains two springs, also indicates the control setting.

With panel board space at a premium, the popular USG 3½" Pneumatic Receiver Gauge is the answer to your problem. Equipped with a statically-balanced frictionless movement, with precision generated teeth and polished bearings of top aircraft quality, these small size gauges achieve a perfection in performance previously not thought possible of a pressure gauge.

FEATURES

Ranges: 3 to 15 p.s.i.g. stocked, 3-18 p.s.i.g. also available.
Scale: A variety of scales available.
Case Diam.: 3¾"
Bezel Opening: 3½"
Pressure Elements: Phosphor Bronze, AAA width, stress-relieved.
Movement: Aircraft quality — phosphor bronze and stainless steel.
Adjustments: ±1% maximum linearity adjustment with adjustable tip; micro-adjustable pointer permits rotation with respect to pinion for zero adjustment.
Stops: Zero and over-range.
Case: Drawn steel, black crinkled finish, bevelled glass.
Socket: Extruded brass.

SINGLE OR DUPLEX TYPES—The USG Receiver Gauge is graduated to the same scale as the transmitter gauge yet operates at a very small pilot pressure. It is available with a single spring or double spring (Duplex Receiver Gauge).

GAUGES CARRIED IN STOCK—USG Receiver Gauges are stocked without dials in the range of 3-15 lbs. This permits easy assembly and quick shipment of gauges with dials calibrated to your choosing. Single-spring gauges are available in ¼" low male or center back connection. Duplex gauges are available in low back connection with ⅛" or ¼" male pipe thread and 5/16-28 tubing connection.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

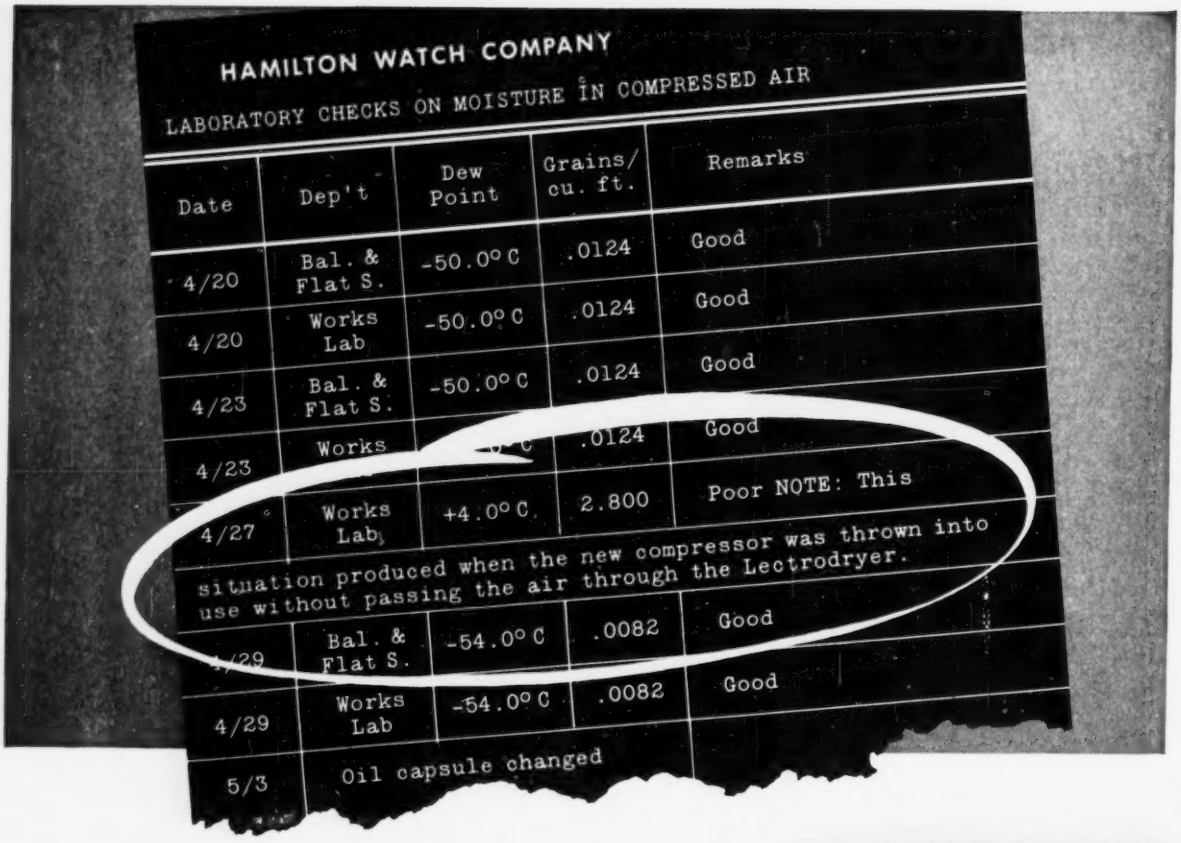
UNITED STATES GAUGE

Quality Gauges Engineered for Enduring Accuracy

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude-Gauges • Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC., AT SELLERSVILLE, PA.:
GOTHAM INSTRUMENTS AND AUTOBAR SYSTEMS

For more information circle **22** on inquiry card.



HAMILTON WATCH COMPANY

LABORATORY CHECKS ON MOISTURE IN COMPRESSED AIR

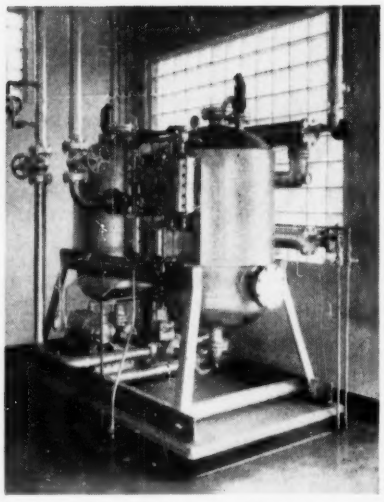
Date	Dep't	Dew Point	Grains/ cu. ft.	Remarks
4/20	Bal. & Flat S.	-50.0° C	.0124	Good
4/20	Works Lab	-50.0° C	.0124	Good
4/23	Bal. & Flat S.	-50.0° C	.0124	Good
4/23	Works		.0124	Good
4/27	Works Lab	+4.0° C	2.800	Poor NOTE: This situation produced when the new compressor was thrown into use without passing the air through the Lectrodryer.
4/29	Bal. & Flat S.	-54.0° C	.0082	Good
4/29	Works Lab	-54.0° C	.0082	Good
5/3	Oil capsule changed			

A lab man's notebook tells why you need Lectrodryers*

Page after page, the report on moisture conditions was "Good". Then *wham!* It jumped from a hundredth grain per foot of air to 2.8 grains. Howls of protest were heard all through this plant —"What's happened to our air?"

A new compressor had been placed in service, bypassing the old Lectrodryer. A quick switch was made and again the report became "Good".

Lab men's notebooks all over the world are telling this same story: Air is kept free of unwanted moisture by Lectrodryers, assuring dependable functioning of air-operated instruments. For help in determining what Lectrodryers will do for you, write Pittsburgh Lectrodryer Corporation, 330 32nd Street Pittsburgh 30, Pennsylvania.



The new Type BY automatic Lectrodryer gives you DRY air at minimum investment

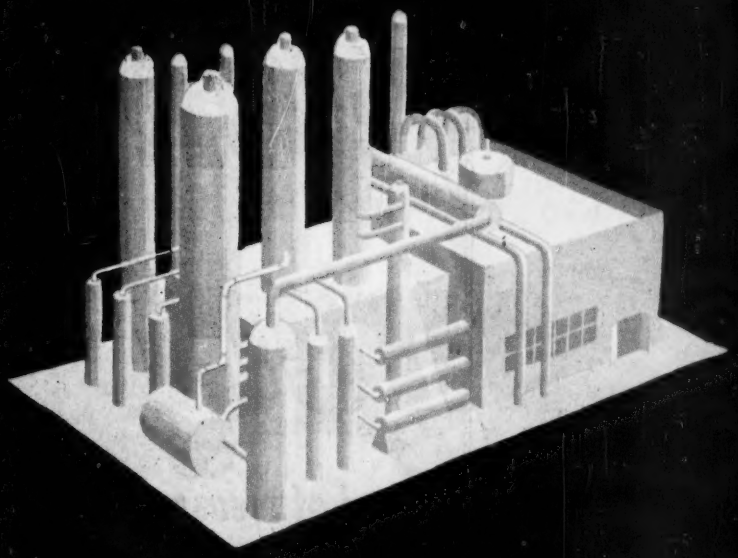
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

For more information circle 23 on inquiry card. Circle 24 on inquiry card. ⟶



will prevent processing headaches

The increasing complexity of petrochemical processing will call for automation beyond today's approach to measurement and control.

Continuous analyzers, for example, point to a significant trend toward "thinking machines," which may ultimately control a whole process on the basis of desired qualities in the finished product. Honeywell has helped to implement this and other new concepts, and will continue to work toward the realization of practical automation.

While the capabilities of instrumentation are being extended, so too is its dependability. For the more automatic a plant gets, the greater becomes the responsibility on the automatic equipment which keeps processes coordinated.

Long identified with instrumentation's parade of progress, Honeywell's Industrial Division serves the petrochemical industry from lab to pilot plant to "on-stream" operation. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for your copy of "How Automatic Can We Get?"—a challenging discussion of the future of instrumentation.

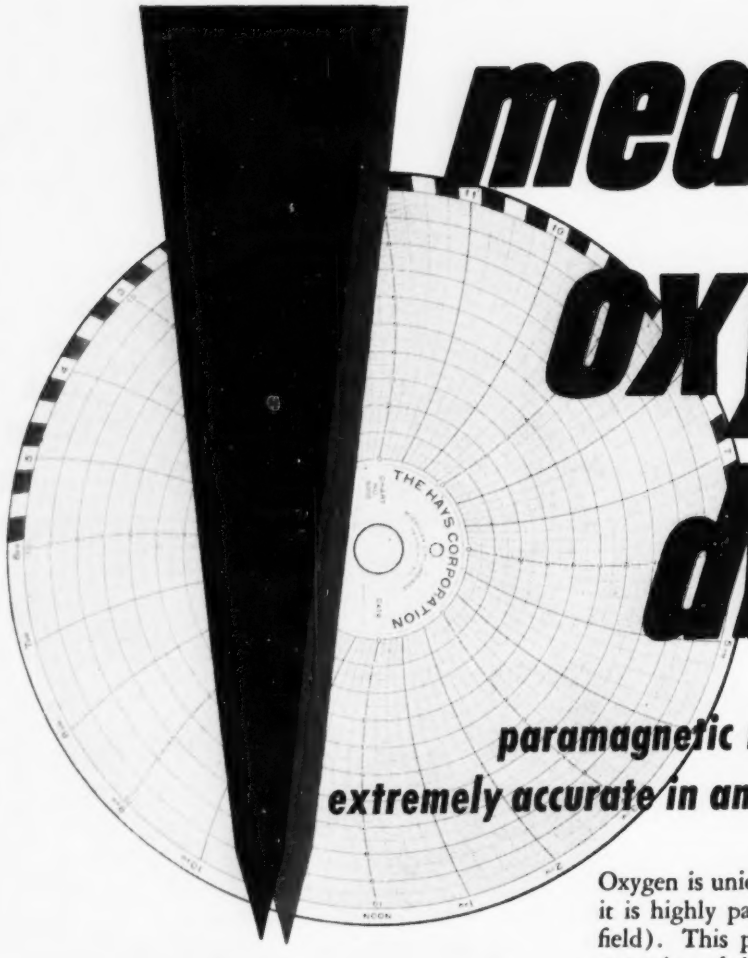
MINNEAPOLIS

Honeywell

BROWN INSTRUMENTS

First in Controls

measure oxygen direct



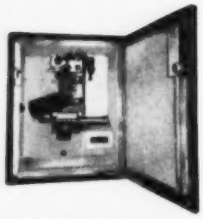
paramagnetic method of measurement extremely accurate in analyzing industrial gases

Oxygen is unique among other common gases in that it is highly paramagnetic (attracted into a magnetic field). This property of oxygen is the basis of the operation of the Hays Magno-Therm Analyzer in the analysis of industrial gases.

application

Hundreds of companies are using the Hays Magno-Therm O_2 Analyzer and Recorder in applications from revivification of SO_2 removers in manufactured gas industry and regeneration of catalysts in oil refineries to mixing air with propane to get substitute fuel. Boiler plants use it as a combustion guide because it is the only means of getting an undistorted picture of excess air.

Write today for bulletin 52-829-56 and get complete details.



ANALYZER

Highly sensitive to changes in oxygen content.

Rapid response to changes in oxygen content.

No liquid or gaseous fuel required to be added to gas sample.

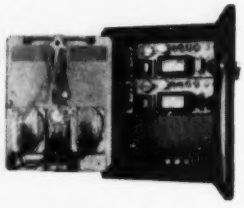
No chemicals required.

High accuracy maintained.

Not affected by wide variation in rate of flow of gas sample.

Rugged construction. No delicate or moving parts.

Easily installed — no special fittings required.



RECORDER

Self-balancing bridge circuit assures accurate, permanent calibration.

Electronic amplifier has no moving parts. High sensitivity. Rugged.

Immediate response—analyzer is continuously connected to recording pen drive motor.

As many as four analyses can be recorded on the same chart.

Range can be changed easily in the field.

Isolating transformer for each amplifier removes line interference from bridge circuit.

Extra slide wire available for control, remote indication—for recorder or contacts for alarm circuit.

Automatic Combustion Control Boiler Panels • CO_2 Recorders Veriflow Meters and Veritrol Gas Analyzers • Draft Gages Combustion Test Sets Electronic Oxygen Recorders Electronic Flowmeters Electronic Feed Water Controls Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY, INDIANA

For more information circle **25** on inquiry card.

TRADE PAPER EDITION
Published by
SCHUTTE and KOERTING
Company

ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • GAUGE GLASS TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • STEAM PUMPS • DESUPERHEATERS

Here's SK's NEWEST DESIGN for Rate-of-Flow Measurement—the SAFEGUARD ROTAMETER

As an answer to industry's increasing demands for *safety* and *convenience* in rate-of-flow measurement of liquids and gases, SK has designed its newest Rotameter—the Safeguard Rotameter.

This Rotameter has specific application for measurement in the higher temperatures and pressures of modern process technology, or where dangerous or valuable liquids and gases are being used.

FOR SAFETY:

The completely enclosed steel meter case has detachable safety glass windows, protects the metering tube from external shock, and also protects the operator if accidental tube breakage occurs.

FOR CONVENIENCE:

Wider front and rear sight glass windows give maximum visibility. The detachable metal reference scale can be supplied in either units of flow or in millimeters for use with calibration charts, as desired.

Extreme construction rigidity gives precise end fitting alignment, eliminates pipe stresses on the tube.

Can be adapted for remote recording and controlling of fluid rate of flow.

Write for full information, including sizes and capacities, on this newest Rotameter design.

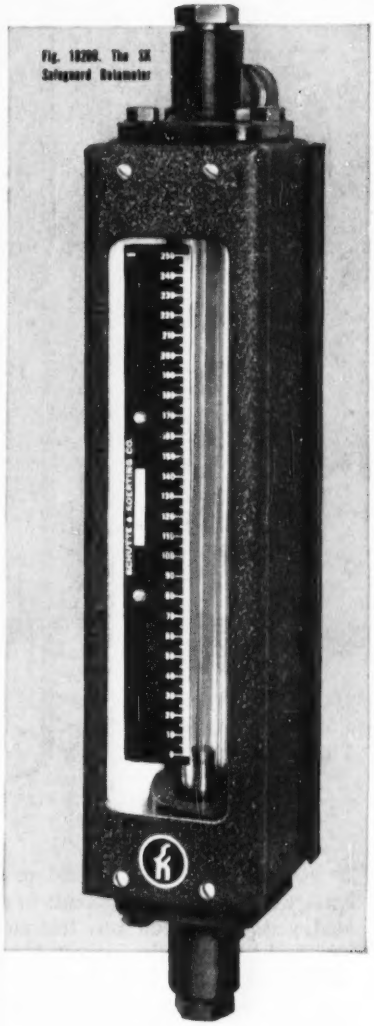


Fig. 18200. The SK Safeguard Rotameter

Glass metering tube has cylindrical inlet and outlet pieces of the *same outside diameter* — allowing use of the same size packing rings on either end of the tube.

Horizontal inlet and outlet can be connected in four *different* positions.

Two types of metal mandrel made tubes are available—the "HCF," a High Capacity Fluted tube, or the "R," a conical tapered tube without flutes.

Various rotor designs and materials permit wide capacity range within one meter.

End fittings are available in cast iron, bronze, and stainless steel.

Neoprene packing gives corrosion resistance, tight seal, long service life. *Other* packing material is available.

Rotor removal and tube cleaning without dismantling easily done through non-leaking seated clean-out plug.

SCHUTTE and KOERTING Company
Manufacturing Engineers
26 STATE ROAD
CORNWELLS HEIGHTS
BUCKS COUNTY, PA.
Representatives in Principal Cities

For more information circle **26** on inquiry card.

Where there can be no leakage

this instrument eliminates guesswork

IF YOU have a highly critical process such as manufacturing hermetically sealed instruments or sealing components in evacuated glass tubes you can tolerate no leakage. For detecting incredibly small leaks in such low-volume, low-pressure applications, there is only one instrument sensitive enough to do the job—Consolidated's mass-spectrometer-type Leak Detector. For less critical work, involving the use of hi-vacuum equipment, high-pressure cylinders, containers having welded or soldered joints, or valves moving on an assembly line, this versatile leak detector is the perfect instrument, guarding the effectiveness of your process and guaranteeing the quality of your product.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Philadelphia, New York, Chicago, Dallas*

analytical instruments for science and industry

Leak Detector *Consolidated's Model 24-101A* detects, locates, and measures leaks in the micron range where it would take 31 years for one cubic centimeter of gas to escape. Request CEC Bulletin 1801-X11.

For more information circle **27** on inquiry card.

Circle **28** on inquiry card. ⟶

NEW

Ratographic* MINIATURE RECORDER

Handles 4 separate signals

Wider application of miniature instrumentation to your own needs is now possible with the new Fischer & Porter Ratographic miniature recorder. Fitting a panel area only six inches square, the instrument *records* two variables and *indicates* two variables—OR—*records* three variables and *indicates* a fourth. It combines the same dependability, stability and accuracy which characterize *all* Fischer & Porter instruments, large and small. Check the many advantages of this instrument as listed here, then write for further information. Fischer & Porter is always ready to supply engineering assistance on *your complete process instrumentation.*

for recording . . .

- four simple and dependable capsule receivers
- 4" *rectilinear* chart, air or electric drive
- outside dimension 6" square
- convenient daily chart tears off without chart waste

for controlling . . . with F&P point of measurement controller mounted as illustrated, unit offers:

- record of both uncontrolled and controlled variables, with indication of valve and set point signals.
- large, easy to adjust external transfer valve and set point knobs

Glass door: no warping, scratching, or crazing. Recording, indicating and controlling functions continue to operate when chassis is extended from front of panel.

complete process instrumentation

FISCHER & PORTER CO.

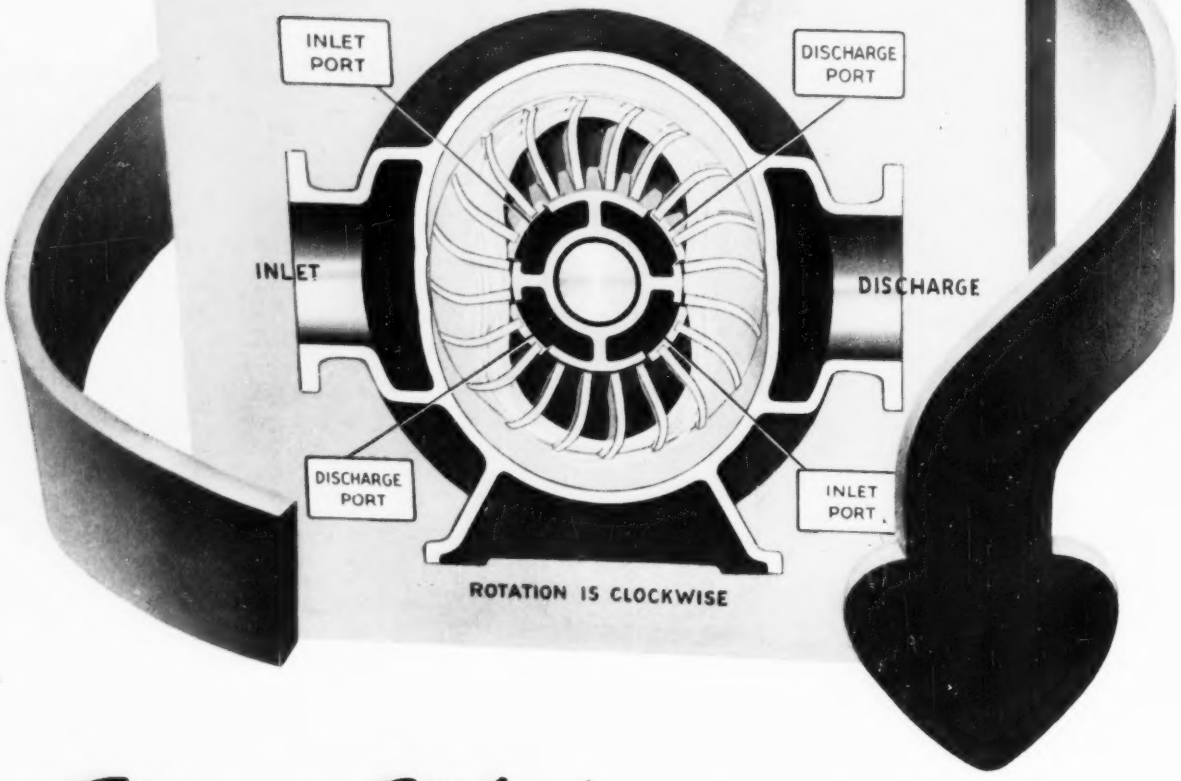
1420 County Line Road, Hatboro, Penn.

*T.M., F&P Co.

2262

Company owned sales and service branches strategically located throughout the world.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

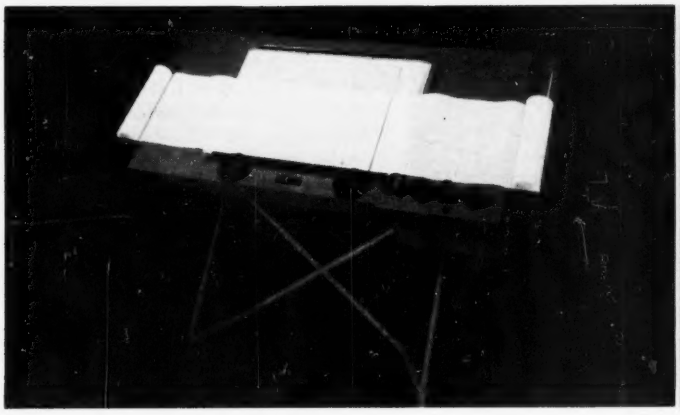
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

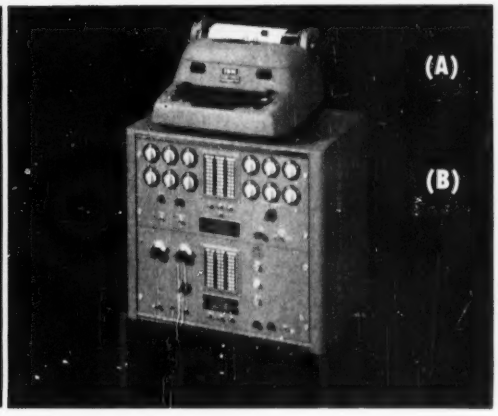
Telecomputing announces:

the first low-cost data reduction system

Everyone concedes the value of modern data reduction instruments; but not every organization feels it can "afford" them—just yet.

A pioneer in the field of data reduction, Telecomputing has long sought a solution to this problem. It now presents the first low-cost data reduction system which offers speed, accuracy and flexibility at a price most organizations can afford: $5,555.





1 **The Contact Telereader** **$2195**

measures oscillograms and other graphic records. It handles single sheet or roll records—any length, any width up to 18"; performs linear and non-linear calibrations; provides accuracy to .01" per count; permits up to 40 measurements per minute by means of X-Y crosswires.

Operates Alone

The Contact Telereader also can be used independently of the data reduction system to perform rapid, accurate measurements. Readout, however, must then be made by manual methods.

Engineers—Telecomputing offers you a future in fields of the future—data reduction, computing, and the solution of mass record-handling problems for Business.

2 **The Teleducer** **$1690**

electronically converts Contact Telereader measurements into digital form.

Other Teleducer Applications

The Teleducer can be used by itself as a laboratory digital voltmeter with an accuracy of 0.1%. It can also be used independently to digitize output of strain gauges and thermocouples without D. C. amplification. It provides for minimum full-scale input of 10 millivolts (10 microvolts per count) and maximum full scale input of 1.0 volt without external attenuation.

The Teleducer and accompanying Program Unit are housed in the same cabinet.

3 **Electric Typewriter (A)** **$920**

The Program Unit (B) **$750**

prepares parallel digital data for serial readout to the electric typewriter shown on top of the Teleducer-Program Unit cabinet.

Readout can also be in punched cards or punched tape.

Specifications on the new data reduction system, as well as detailed information showing how the Contact Telereader and Teleducer can be used independently, will be mailed you upon request. Coupon is for your convenience.

TELECOMPUTING CORPORATION

BURBANK, CALIFORNIA WASHINGTON, D. C.

Turn hours into minutes with automatic data analysis

Mr. Preston W. Simms, I-12
Telecomputing Corporation, Burbank, California

- ☐ Please send me specifications on the data reduction system.
- ☐ Please send me specifications showing how the Contact Telereader can be used alone.
- ☐ Please send me specifications showing how the Teleducer can be used alone.

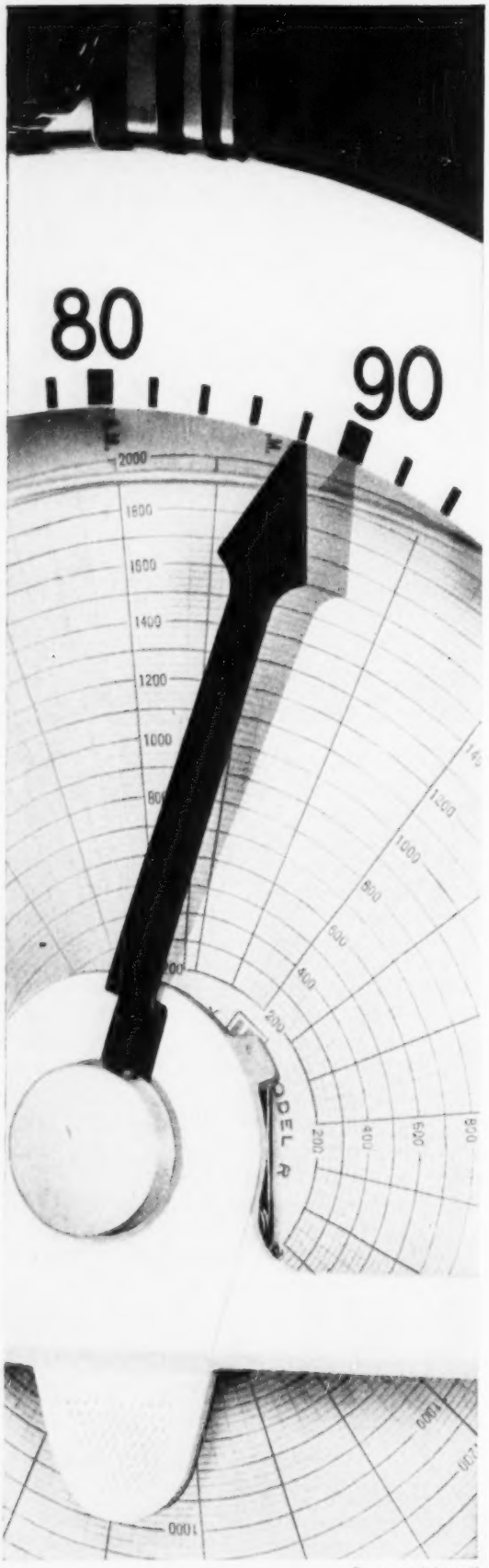
Name

Company

Street Address

City and State

For more information circle **29** on inquiry card.



"We never see the red pointer!"

● That's how enthusiastic users describe performance of an L&N Pneumatic Controller—the Speedomax® round chart model. It's their way of saying a process is under strict control.

Actually, the black pointer—the real measuring index—moves along the same scale as a red one behind it, which has been preset to show the desired control point. Because L&N Pneumatic Control keeps a process so precisely, so dependably, at this matched-pointer position, the black indicator appears to "freeze" over the red. Thus at a glance—from practically anywhere in the room—the operator sees that his product is on-spec.

Pointers match to your requirements

• Perfect "Tuning" to any Process—Wide-range control-function adjustments include a 1 to 1000% proportional band.

• Flexibility of Application and Operation—Pneumatic circuit is easily adjusted for individual control conditions. Control-point setter and handy manual control knobs are mounted externally, permitting operator to make changes quickly, surely.

• Faster Recovery from Upsets—Recorder-controller has "lightning" response to instantly check unavoidable process upsets. Where process lags are a factor, optional use of stabilized rate action heads off process swings almost before they start. In many cases this cuts recovery time by one-third.

• Longer On-stream Runs—Unique "O" ring construction with tubeless assembly permits on-stream operation about 99.9% of the time.

• Advantages of Speedomax Systems—They can be applied in the measurement of temperature, gas analysis, electrolytic conductivity and pH.

For further information, write our nearest office, or 4955 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP
instruments automatic controls • furnaces

Jrl Ad ND4(6)

For more information circle **30** on inquiry card.

Editorial Comment

1953—1954

THE INSTRUMENTS PUBLISHING COMPANY sends its very best wishes to every reader for a Happy New Year. We believe that each of you is in the vanguard of a great movement, a new industrial revolution. This great crusade goes by many names—instrumentation, automaticity, automation, automatization, control engineering, system engineering, cybernetics—all of which refer to the use of instruments for probing nature's secrets, gathering data, analyzing the data, and using them to increase productivity and our standard of life.

The coming year will bring several changes. First, this is the last issue of the magazine that will contain the *Journal of the ISA*. The rapid growth of the Instrument Society of America has led to increased demands for publication space—more than we can provide in *Instruments*. Therefore, the ISA announces publication of the *Journal of the Instrument Society of America* starting in January 1954.

Instruments wishes every success for its new contemporary, and The Instruments Publishing Company will continue to assist the Society as it has in the past. Many of the society-support activities on the part of The Instruments Publishing Company began before the national society started—editorial space was given for meeting announcements; the names of subscribers to *Instruments* were turned over to the several local instruments groups, as well as to the national society when it was founded, for membership solicitation; financial assistance was rendered when needed; free management and direction was given. This cooperation will continue. Special group rates will continue to make *Instruments* available to all ISA members.

The second change you will see in 1954 is a change in our name. Effective January 1954, and emphasizing the increasing importance of automatic control techniques, the name of the magazine *Instruments* will be *Instruments and Automation*.

The third change in store for you includes expanded features and coverage. In 1953 we brought you 1790 new-instrument reviews and 2062 new-literature releases, all indexed and classified for your easy and rapid use. Next year you will receive more reviews and releases, more technical articles, more application items, and several new features and columns in *Instruments and Automation*.

In 1954 each subscriber to *Instruments and Automation* will receive—free of charge—the expanded second edition of *The Handbook of Measurement & Control*. Chapters now are being added on a variety of measurement and control subjects. This edition, plus *The Instruments Index*, which you received with the August issue of *Instruments*, gives each reader a wealth of information on all aspects of the field of instrumentation.

The value of a technical publication to its readers is difficult to measure. How can the feature articles be evaluated? However, there are two criteria of some utility. One is the fact that you readers pay an annual fee to receive the magazine. This proves that the value is at least equal to the amount you pay. The second criterion is the number of reader inquiries made for more information about the products advertised and reviewed. For those of you who like statistical data, here are the inquiries the readers of *Instruments* made for the five recent months of May, June, July, August, and September, 1953.

INQUIRIES RECORD

Issue	*Advertised Products*	*New Products*	*New Literature*	*Total*
May	2893	2784	4563	10,240
June	2898	3018	3452	9,368
July	2142	1731	3270	7,143
August	3691	2769	2486	8,946
September	2465	3093	2352	7,910

On the basis of these figures, plus the inquiries from *The Instruments Index*, more than 110,000 reader inquiries will have been received by us and referred to the instrument manufacturers for the year 1953. When one man uses one instrument to make one measurement or to perform one control action automatically, something useful is added to the sum total of our technical civilization, the national living standard is increased one bit further. Hence if we can measure the services rendered by *Instruments* in 1953 by the 110,000 inquiries that you readers made for more information about instruments, if only a small percentage of the inquiries resulted in new application of instruments in the laboratories and plants of America, we can say that our efforts in 1953 were successful; and we rededicate ourselves to making your work more efficient and productive in 1954.

ISSUES

The Counter Reads 0 0 3 1 2

and thereby registers the end of the twenty-sixth year of *Instruments'* service to users of measurement and control devices—service to THE UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and A Happy New Year

The Month's NEW INSTRUMENTS

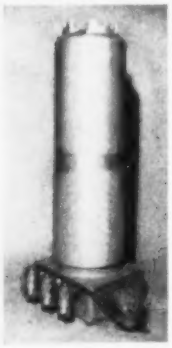
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1935

PROCESS CONTROL (and not otherwise classified)

Infrared Gas Analyzer

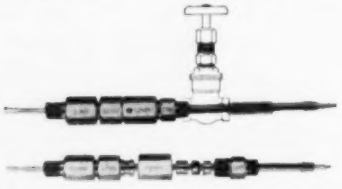
New modification of maker's standard "Model 21" infrared gas analyzer increases sensitivity to where changes as low as 1/3 part per million can be detected. Originally developed and successfully employed for measuring CO and CO_2 in range of 0-50 ppm. in ammonia synthesis gas, new model has other applications where extreme sensitivity is desired. Analyzer being basically sensitive to number of molecules in optical path, sensitivity is increased by employing high sample pressures: 500-psi. pressure is employed in CO and CO_2 instrument, with sapphire windows which can safely withstand much higher pressures.—*Liston-Becker Instrument Co., 649 Hope St., Stamford, Conn.*



For more information circle **201** on inquiry card.

Change-under-pressure Thermocouple Gland

New "C-U-P" (change-under-pressure) gland permits changing exposed-wire thermocouples without reducing pressure on system, hence without interrupting operations. It comprises maker's "Thermocouple Gland" equipped with an open-end protection tube, maker's special "Packing Gland" and a gate valve. Blow-back of tube through packing gland is prevented by set screw; and tube cannot be removed from packing gland before closing gate valve. "C-U-P Glands" are capable of sealing several thousand pounds per square inch. Temperature range is determined by the sealants: asbestos-graphite 700 F., others lower.—*Conax Corp., 4515 Main St., Buffalo 21, N. Y.*



For more information circle **202** on inquiry card.

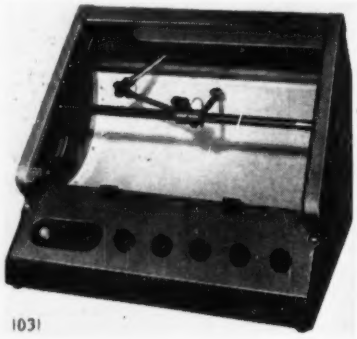
Six-point and 24-point Round-chart Recorders

New 6-point and 24-point round-chart recorders are available both as a-c. self-balancers or as "Tektologs." Each unit is equipped with a 6-point turret pen which provides 6 different colored traces. Full print cycle for 6 points, on standard unit, takes 30 seconds. 24-point recorder combines 6-point and segmental recording: chart is divided into 4 segments each equivalent to either 8 hours, 24 hours, or 7 days; on each segment 6 different colored traces are drawn. 24-point print cycle, on standard units, is accomplished in 2 minutes. On-off control can be provided on all points. When cycling mechanism is switched off, multipoint recorder operates as a normal single-point recorder. A-c. self-balancing recorder is designed for a wide range of applications such as resistance bulb thermometry, conductivity, displacement, 3 wire telemetering, etc. In thermometry, nickel bulbs and fittings are available for temperatures up to 600 F. and various standard calibration ranges are supplied. (Also platinum and other high-temperature bulbs.) Basic accuracy, hysteresis and linearity better than 0.5 percent. Other features include quick range and measurement change by replacement of bridge element box which has provision for up to 4 inputs providing means for adding, averaging or subtracting. Simplified unit construction ensures ease of maintenance. Electric or pneumatic control is available.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **203** on inquiry card.

Plot-trace Recorder

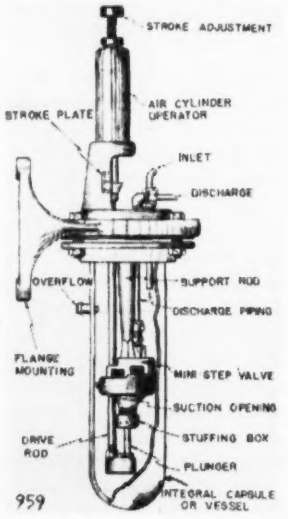
New "X-Y Plotter and Recorder," two-coordinate portable recorder for continuous curve or discrete point plotting, is equally useful for display of digital information, plotting of transistor characteristics or calibration of flow meters, etc. Plotting surface is a stationary concave 120-deg. cylinder and takes either 11x16.5-in. or 8.5x11-in. standard graph paper held down by magnetic clips. Ink supply is pressure regulated; origin may be shifted to any part of chart; zero offset and scale expansion of both axes is continuously variable over 10:1 range; pen can be directed to plot or trace by single switch control. X-y recorder is accurate to 0.1 percent full-scale. Available accessories include punch card converter, decimal keyboard unit, analog or digital inputs or polar coordinate input.—*Librascope, Inc., 1607 Flower St., Glendale 1, Calif.*



For more information circle **204** on inquiry card.

Controlled-volume Pump for Submerged Operation

New controlled-volume pump for submerged operation is designed especially for handling dangerous fluids. Entire liquid-end assembly is submerged in a sump with only driver and discharge piping exposed. With pumping cylinder submerged, problems of stuffing box leakage are eliminated. Capacities up to 3200 ml./hr.; pressures up to 1000 psi.—*Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.*



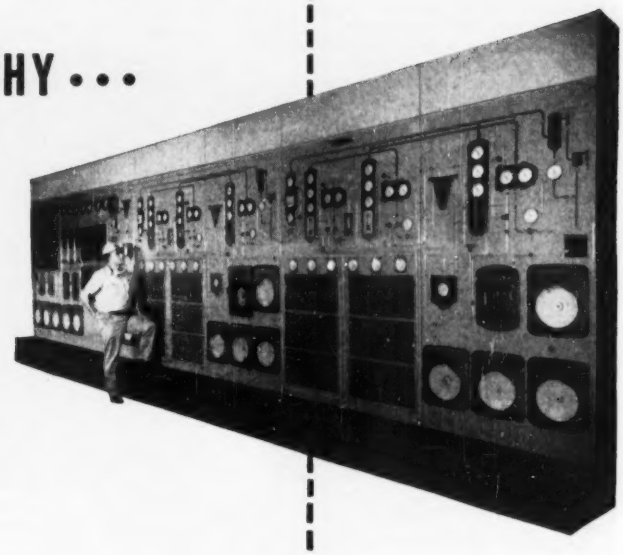
For more information circle **205** on inquiry card.

Smoke Density Comparator

New "Smokescope," for indicating density of smoke in stack effluent, is said to overcome causes of error inherent in previous devices, e.g., differences in lighting or background; makes it unnecessary to re-focus one's eye as when looking alternately at smoke and at a comparison chart:

6 REASONS WHY...

PANELLIT is the largest builder of process control panels



1 **SPECIALIZED ENGINEERING** . . combining instrumentation and process experience, PANELLIT provides sound and economical engineering as a part of their service.

2 **ADVANCED STANDARDS OF CONSTRUCTION** . . . have distinguished PANELLIT in every detail of structure, finish, piping, terminal arrangements and serviceable behind-the-panel layouts.

3 **PIONEERING CONCEPTS OF INSTRUMENTATION** . . . the graphic control panel, miniature instrumentation, unitized annunciator systems, scanning and monitoring devices . . . all have been closely associated with PANELLIT.

4 **ORGANIZATIONAL FLEXIBILITY** . . . Few process control panels are ever shipped without changes. When "change orders" are received, PANELLIT moves quickly to carry them out . . . without confusion . . . without delay. Where others take weeks, PANELLIT takes hours.

5 **THE ONE MAN PLAN** . . . makes PANELLIT easy to work with. One project engineer stays with your job. There are no "pass along instructions" or "round about authority".

6 **INFORMATION SYSTEMS** . . . an advanced PANELLIT concept of the control panel has resulted in better process control. An *information system* filters information for the operator to know . . . and presents it in a manner that he may act quickly and instinctively. ***Write for complete information.***

PANELLIT

INFORMATION SYSTEMS

PANELLIT, INC., 6312 N. BROADWAY

CHICAGO 40, ILLINOIS

For more information circle **31** on inquiry card.

a lens projects an image of reference standard to a focal distance equivalent to that of stack. No interference by stray light because user views smoke through apertures limiting field of vision.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **206** on inquiry card.

Remote-control Systems

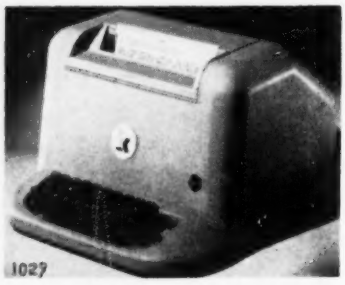
New remote-control systems provide remote control of electrically-operated devices and machinery by means of r.f. carrier signals trans-

mitted over existing power lines. Receivers are completely immune to line noise disturbances. Units require no installation or special wiring, can be easily relocated to serve a variety of applications. Receiver "Model RC-5" for loads up to 5 amps., and "Model RC-20" to 20 amps., are used in conjunction with Transmitter "Model RT-1" which delivers control signal. Other models available for specialized applications.—*Vocaline Company of America Inc., 13 Coulter St., Old Saybrook, Conn.*

For more information circle **207** on inquiry card.

Teleprinter

New teleprinter designed to send and receive messages at 100 words per minute (actually capable of 150 w.p.m.) weighs 45 lbs. and contains

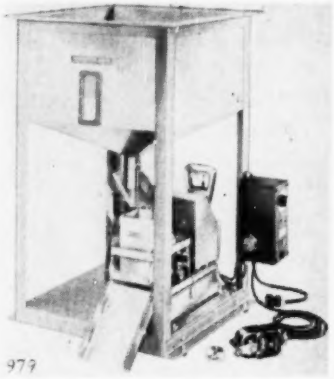


30 percent fewer moving parts than those in use. When receiving from a previously prepared perforated tape, it can hit a top speed of 15 characters a second regardless of how slowly message originally was typed. Two standard versions: "Model 150," essentially Signal Corps unit converted for commercial use; "Model 155," a further streamlined version which provides all features essential for most commercial purposes.—*Kleinschmidt, Inc., Deerfield, Ill.*

For more information circle **208** on inquiry card.

Automatic Gravimetric Plastics Feeder

New "Model 213-F-00-IM Net Weighing Machine" is designed to weigh-feed a predetermined weight charge of molding material to plastic

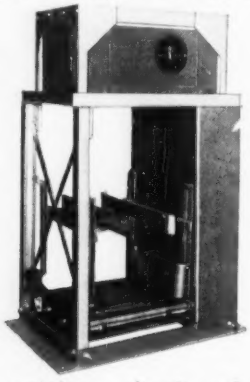


injection molding machine, replacing normal hopper. Weighing scale of new machine is maker's even-balanced system with "over-and-under" indicating dial. Weigh-platter and notched beam with sliding poise permit quick set-up of any weight. Weigh bucket fills to exact weight, holds material until molding-machine ram trips switch, and dumps charge into injection feed chamber. Delivery is positive and synchronization guarantees only one charge per ram cycle.—*The Exact Weight Scale Co., Columbus 8, Ohio.*

For more information circle **209** on inquiry card.

Automatic Weight-checking Conveyor Scale

New "Model 100S Checkweight Scale" checks and indicates the weights of filled packages before they have been closed, discharges properly-



filled containers, signals and holds off-weights—all automatically. If package is underweight only, or either underweight or overweight, it may be either discharged while a horn sounds or held on scale conveyor while a horn sounds. In latter case, package then may be either removed by hand or advanced from scale by pushing a button. Unit includes a totally enclosed electromechanical weighing mechanism, two weight-indicating dials, motor-driven conveyor belt, conveyor, automatic horn and controls. Should any broken bags or cartons pass over conveyor, loose material will fall through to floor and will not alter tare weight of scale.—*Thayer Scale and Engineering Corp., East Water St., Rockland, Mass.*

For more information circle **210** on inquiry card.

Automatic Gravimetric Plastics Feeder

New "500 Series Injecto-weigh" is said to be "the first practical weigh-feeding machine for injection molding of plastics"; replaces existing hopper

and feed mechanism on molding machines, and mounts easily on any standard molding machine. Among improvements: Bucket-operating mechanism redesigned to make operation more foolproof; storage hopper now mounted on a new type of shock absorber; all adjustments and controls now mounted on right-hand side for operator's convenience (unit is completely automatic, but manual controls are provided for convenience); larger weigh bucket (350 cu. in.) makes unit more readily adaptable to larger molding machines; new method of bucket gate operation prevents seizing or jamming.—*Glengarry Equipment Corp., Bay Shore, N. Y.*

For more information circle **211** on inquiry card.

Banbury Mixer Feed Control System

New system for controlling weight of blended materials in Banbury-type mixers controls weight of each ingredient, either liquid or solid. It operates auxiliary devices to: (1) operate vibratory feeders to supply exact amount of new solid base material to weigh hopper from either of two blenders; (2) sound alarm when one blender is empty and automatically switch feed to second blender; (3) add exact amount of reclaimed base material to weigh hopper in accordance with desired batch size and ratio of new-to-reclaimed material; (4) dump weigh hopper into skip hoist which carries base material into mixer; and (5) dump desired weight of liquid plasticizer into tank from which operator draws during blending. System now controls two solid materials and one liquid, but is easily adapted to handle additional compounding ingredients. Accuracy of feeding liquid plasticizer is within 2 lbs. in 800.—*CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Penna.*

For more information circle **212** on inquiry card.

0.38-0.70-micron Recording Spectrophotometer

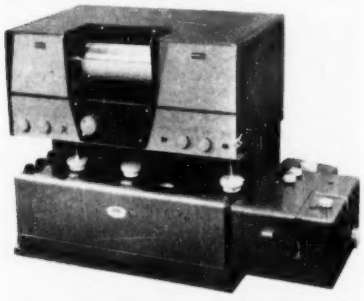
New recording spectrophotometer for industrial use in setting up standards to control color of paints, dyes, glass, textiles, etc., is redesign of

maker's laboratory instrument. It now furnishes a rapid color analysis by drawing a complete didymium curve in 54 seconds with photometric accuracy of 0.5 percent, wave-length accuracy within 1.0 millimicron, and photometric precision within 0.2 percent. Range of 0.38 to 0.70 microns anticipates any new ICI colorimetric standards. A semi-skilled person can operate equipment. Routine operation is largely automatic.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **213** on inquiry card.

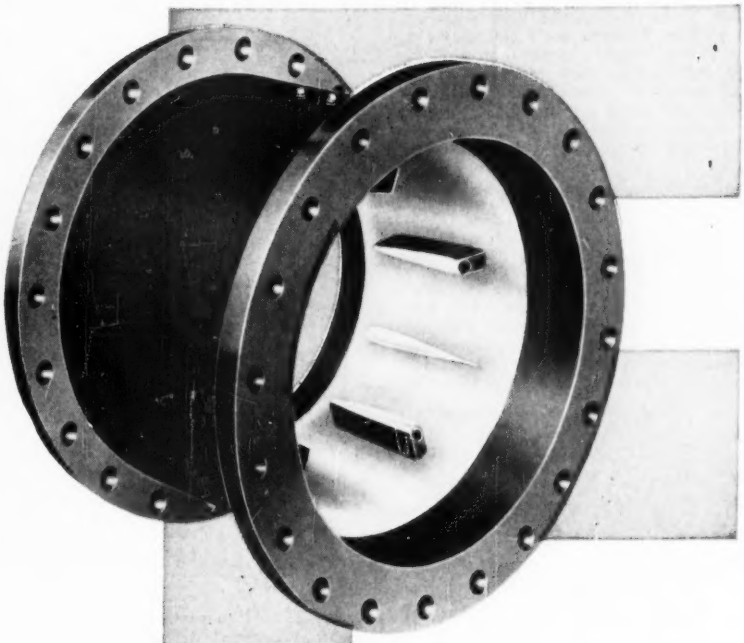
0.21-1.00-micron Recording Spectrophotometer

New "Model DR" automatic recording spectrophotometer is built around single-beam quartz monochromator of maker's "Model DU" spectrophotom-



eter. It automatically measures and records percent transmittance in 0.210-1.000-micron region. Entire ultraviolet to near-infrared span is broken up into selectable wavelength ranges. As many as three samples can be run simultaneously, with each curve plotted in a different color. Scanning speeds exceed fastest manual plotting: 8 seconds to record a point for one sample, 10 sec. for two and 12 sec. for all three. Spectrograms are made on standard 8½ x 11 graph paper. Operation is always at highest resolution of which instrument is capable for optimum signal-to-noise ratio, so that in most cases accuracy will surpass that of most skilled manual operator. Once controls have been set, instrument can run by itself for a whole day, with

FOR OVERALL ECONOMY



CHOOSE A FLOW TUBE

Flow Tubes offer economies all through their long service lives.

First cost is low. Installation costs are low, too, because Flow Tubes can be installed inside the plant. They are short, compact, and require only minimum straight runs entering and following. No expensive vaults are needed.

Operating costs are low. They require little, if any, maintenance. Pumping costs are low because Flow Tubes are available in types and D/d ratios to handle a wide range of fluids and main line velocities. This enables you to use the one Flow Tube that will produce differentials that can be accurately measured, with the least head loss.

All Flow Tubes are furnished with head capacity curves obtained in laboratory tests, and can therefore be guaranteed as to accuracy.

That's why Flow Tubes are being successfully used in scores of installations metering the flow of liquids and wet or dry gases. Available in all pipe sizes and suitable metals. They can be furnished with or without suitable secondary indicating, recording or totalizing instruments. Write for further information. For specific recommendations, send us necessary flow data.

FOSTER ENGINEERING COMPANY · ESTABLISHED 1919 · FOSTER AUTOMATIC VALVES

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • CUSHION CHECK VALVES • FAN ENGINE REGULATORS • PUMP GOVERNORS • TEMPERATURE REGULATORS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN VALVES • VACUUM REGULATORS OR BREAKERS • STRAINERS • SIRENS • SAFETY VALVES • FLOW TUBES

FOSTER ENGINEERING COMPANY · UNION, N. J.

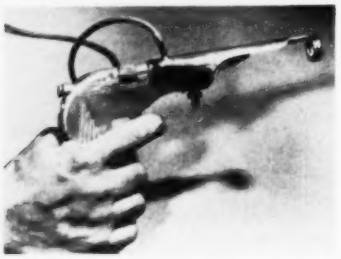
For more information circle **32** on inquiry card.

operator needed only to change samples, chart paper and scanning regions. It is possible to vary number of points plotted automatically in any given range. Automatic unit of new instrument can be attached to any standard "Model DU" spectrophotometer with no change in monochromator required.—*Beckman Instruments, Inc., South Pasadena 1, Calif.*

For more information circle **214** on inquiry card.

Halide Leak Detector

New attachment for "Century Torch-O-Matic" air-acetylene gas gun is a halide leak detector that permits quick, positive, convenient detection of halogenated gases (such as refrigerants). Air sample drawn through



tube mixes with acetelyne and, as latter burns, any halogenated gases present are decomposed. Products of decomposition, striking hot copper helix, impart a distinctive color ranging from a faint rose for extremely small halogen concentrations to an intense blue for largest concentrations. Color variation enables user to pinpoint location of leakage within a few seconds.—*Velocity-Power Tool Co., 7500 Thomas Blvd, Pittsburgh 8, Pa.*

For more information circle **215** on inquiry card.

Prospecting Magnetometer

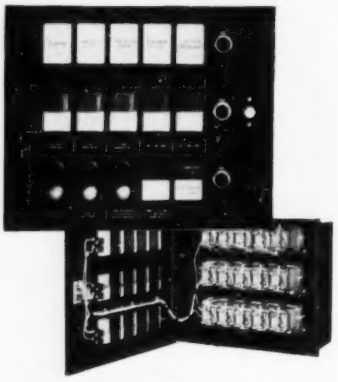
New "D1-M Magnetometer" is a light-weight (5-lb.) prospecting instrument which indicates earth's varying magnetic intensity as affected by local and subsurface anomalies;

ground-checks airborne magnetometer maps; detects negative as well as positive anomalies. Use of new magnetic alloys insures a maximum sensitivity of 70 gammas per scale division. On swing readings, normal sensitivity is 30 gammas per scale division. Scale-value sensitivity can be easily adjusted in field.—*The Radiac Co., Inc., 489 Fifth Avenue, New York 17, N. Y.*

For more information circle **216** on inquiry card.

Alarm Signal System

New "Model 100 Universal Annunciator Plug-in Unit Circuit" with standard unitized components features complete flexibility. Various

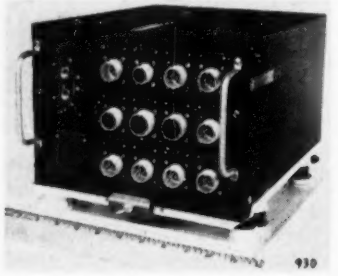


types of visible alarm indications may be incorporated in the same housing for ready recognition by operators and arranged in various groups including backlighted engraved nameplates, 2-lamp circuits with giant turret lenses, bullseyes and two types of two-tone lenses. Although separate types of circuit sequences may be employed, relay plug-in units are uniform standard components, all housed in maker's "Model 440 Unitized Annunciator Cabinets" with wiring accessible either from front or rear.—*—Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.*

For more information circle **217** on inquiry card.

Flight-data Computer

New "C-2 True Airspeed Computer," said to be "the first of its type in the field," is an electrome-

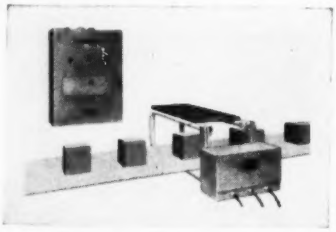


chanical instrument designed to act as a central data source on high-performance aircraft, furnishing multiple outputs of atmospheric pressure, Mach number, and true airspeed. This information may be directed to control ; navigation, bombing, gunfire control and photographic equipment and to provide visual indication for flight crew.—*Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, N. Y.*

For more information circle **218** on inquiry card.

Metal Detector

New general-purpose metal detector utilizes inductance-bridge principle; can be installed around conveyor systems without cutting belt, for in-



spection of non-magnetic and non-conductive materials. Belt speeds can range from 90 to 500 fpm. System is also adaptable for application in paper and lumber industries for small logs, with detecting coil immersed in log pond and logs floated through. Two main components: (1) control cabinet with gasketed door that can be locked to prevent tampering. (2) Coil unit consists of inspection coils and a junction box containing necessary transformers and part of balancing network. Coils are 1½-in. diam. aluminum tubes. Two standard sizes: rectangular with 33x10-in. opening; and 4-ft.-diam. circular coil. Special sizes can be furnished.—*General Electric Co., Schenectady 5, N. Y.*

Also, for complete automatic installations: *Stearns Magnetic, Inc., Milwaukee, Wis.*

For more information circle **219** on inquiry card.

Fluorimeter

New "G-M Fluorimeter," based on an advanced design which obviates need for air or water cooling systems and optics, is for lab or plant service. Basic units are: (1) Ultraviolet light chamber, comprising an aluminum block which holds uv. lamps and containing an opening for sample slide. "Blacklight Blue" lamps used as uv. source develop little heat; no special cooling required. With cooling system eliminated, sample slide, light

source and detecting unit can be mounted in close proximity, making optical systems unnecessary and permitting lower voltage across dynode of photomultiplier tube. (2) Sample slide, which contains compartments for sample melt and a fluorescent standard, automatically centers itself in reading position and activates correct shunt so that standard reading can be checked before and after each sample reading. (3) Detecting unit, located above light chamber, contains

to follow the leader – *precisely* – specify

Doelcam

Synchros

PERFECTION of detail is the difference between a good performance and the very finest — like the coordinated attack and release of a brilliant string section. The precision with which DOELCAM Synchros transmit and receive electrical information is unsurpassed in a precision industry.

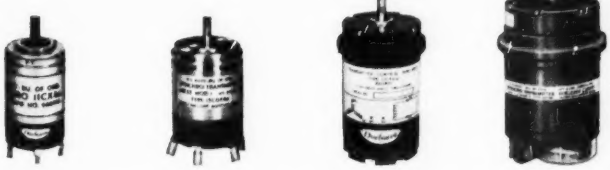
DOELCAM Synchros are tested and perfected standard military components for use in servomechanisms, computers, and automatic control systems. Many thousands have been delivered under Prime Government Contracts, which until recently absorbed our entire output. Now, the added facilities of our new plant enable us to make these outstandingly precise units available for general military and industrial usage. Your inquiry is invited.

Write for Bulletin S4

SIZES and Excitation	TYPES Control Transmitters	TYPES Control Transformers	TYPES Torque Transmitters	TYPES Torque Receivers
SIZE 11 1.062" O.D. 115v 400 Cycles	11CX4a	11CT4a		
SIZE 15 1.437" O.D. 115v 400 Cycles	15CX4a 15CDX4a	15CT4a	15TDX4a	15TR4a
SIZE 23* 2.25" O.D. 115v 60 & 400 Cycles	23CX4a 23CX6 23CDX4a	23CT4a 23CT6 23CT6a	23TX4a	23TR4a 23TR6 23TR6a
SIZE 31 3.10" O.D. 115v 60 Cycles			31TX6	

*All Type 23 Synchros are available with keyed or splined shafts.

Doelcam-designed Torque Receiver Error Tester has established an entirely new quality level for Type "TR" Synchros



SIZE 11
1.062" O.D.
Specification
MIL-S-16892 (BuOrd)

SIZE 15
1.437" O.D.
Specification
MIL-S-16892 (BuOrd)

SIZE 23
2.25" O.D.
MIL-S-12472 (ORD)
FXS-1066 (ORD)

SIZE 31
3.10" O.D.
Specification
MIL-S-12472 (ORD)

Doelcam CORPORATION

SOLDIERS FIELD ROAD, BOSTON 35, MASS.
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

Gyroscopic Instrumentation · Servomechanisms
Synchros · Microsyns · Servo Motors

For more information circle **33** on inquiry card.

a photomultiplier and a set of filters that screen out unwanted light and pass 55-mu. band of uranium fluorescence. To provide automatic overload protection for microammeter, it is automatically set at highest range when sample is introduced into light chamber; correct range for reading fluorescence of sample is chosen and value noted by using convenient keyboard of switches. Because of photomultiplier dependence on voltage, a mu-bridge type regulated power source is employed, with components readily available commercially.—*Jarrell-Ash Co.*, 26 *Farwell St., Newtonville* 60, *Mass.*

For more information circle **220** on inquiry card.

Automatic Tally System

New "Distribution," said to be "the first basic improvement in the system of keeping tallies of orders in the past two centuries," comprises a cabinet, about 7 ft. long and 6 ft. high, and keyboard devices that look like hand adding machines, which feed information into system. It receives tallies of orders, or inventory items, through the keyboards, and within 0.4 second it has added each new item to existing total in its proper catalog classification, and registered new total. It can handle 13,000 items in each three categories. It is not a computer but an adder-classifier with a mag-

netic drum "memory" where each catalog number has an "address." System can separate tallies in different groups, through the use of a "category switch".—*Remington Rand Inc.*, 315 *Fourth Ave., New York* 10, *N. Y.*

For more information circle **221** on inquiry card.

FLOW-RATE and VOLUME METERING

Stainless-steel Meters

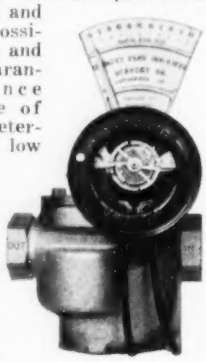
New "Niagara Chemical Meters" make possible accurate volumetric measurement and control of corrosive products: caustic soda, concentrated sulphuric acid, many other acids, ammonia, fruit juices, etc.; also where product purity must be maintained as in metering distilled water. Type 316

stainless steel is used for all parts exposed to metered liquid, except measuring piston—usually made of hard carbon but can be furnished in other materials. A wide variety of registers is offered for continuous or batch measurement purposes, for manual or automatic control.—*Buffalo Meter Co.*, 2906 *Main St., Buffalo* 14, *N. Y.*

For more information circle **222** on inquiry card.

Flowmeter with High or Low Alarm Switch

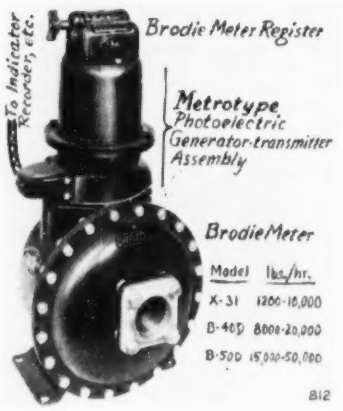
New "Indicating Flow Meter" for free-flowing liquids has sealed-in "Mercoid Switch" with full protection from dirt, dust, and corrosion. No possibility of pitting and sticking; guaranteed assurance against failure of warning. Predetermined high or low flow-rate quickly set on face of switch. Instrument provides a four-way check by visual dial reading and alarm system, lights, or a combination of both. Accuracy is within 3 percent. Controls can be set over full range. Flowmeter proper has only three moving parts, has no delicate mechanisms or complicated parts: simplicity of design is said to make new indicator successful on lines of free-flowing liquids in paper mills, chemical plants, petroleum refineries, food industries, etc., where it can be installed right in the line. Graduations on visual dial are uniformly spaced from zero to 100 percent.—*Henszey Co., Watertown, Wis.*



For more information circle **223** on inquiry card.

Positive-displacement Remote-reading Flowmeter

New "Metrotype-Brodie Flowmeter" combines (1) a standard positive-displacement (not flow-rate) liquid meter and (2) a newly-designed pickup and transmitter assembly comprising: (a) a disk with evenly-spaced holes in its periphery, mounted on meter's register-drive shaft; (b) a light source; (c) a phototube; (d) an amplifier. This assembly imposes no load on liquid meter. Accuracy of meter-transmitter combination is better than



0.5 percent. Telemetering means may be conductor-pair, or carrier, or microwave. Receiving equipment may be a high-accuracy long-scale deflection milliammeter, or a self-balancing potentiometer indicator or recorder, or an electric counter, or maker's printing-type "Digital Recorder," or a combination of indicating, recording, integrating and printing instruments. —*Metrotype Corp.*, 525 *W. 76th St., Chicago* 20, *Ill.*

For more information circle **224** on inquiry card.

TEMPERATURE

Contact-making Thermostat

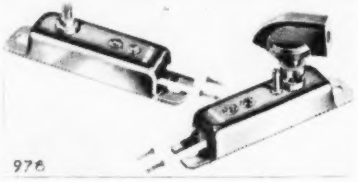
New "Plugstat" for use wherever temperature limit signal is required, has alloy contacts which assure clean-make-and-break. Capable of 200 F.

overshoot from high or low normal setting. Available also with AN connector. Rated at ¼ amp., 28 v. ac. or dc. resistive loads. Contacts n-o. or n-c. Factory set and sealed. Weight approx. 1.5 oz.—*Control Products, Inc.*, 300 *Sussex St., Harrison, N. J.*

For more information circle **225** on inquiry card.

Surface Thermostat

New thermostat for controlling surface temperatures is a rigidly constructed unit: deep-drawn housing (brass or steel) withstands mechani-



cal shock. Strip-type construction is such that thermal responding element is insulated from switch and carries no current. All live metal parts are shielded: unit is shockproof. It can be mounted in any position. "Model HS" (adjusting screw) 2.5 x 0.75 x 0.5 in.; "Model HK" (adjusting knob)

FOR APPLICATIONS IN RADAR, TELEMETERING, DIGITAL COMPUTING, TELEVISION, NUCLEAR PHYSICS

Coincidence Detector, Type 1201B, another of the basic elements in Burroughs' line of "Unitized" Pulse Control Equipment.

"Unitized" Pulse Control Equipment

permits fast, easy readaptation of electronic test circuits

Speedy assembly of electronic testing equipment is one big advantage you gain when you use versatile Burroughs pulse control units . . . but there is another tremendous advantage that *only* "Unitized" equipment offers. Since each Burroughs unit performs just *one basic operation*—such as generating, counting, mixing, gating, or delay—it's easy to *reassemble* equipment for a *different* project when one set of electronic tests is completed. You simply make a block diagram of the new circuit needed and rearrange the cables to correspond to your diagram. This flexibility permits you to quickly perform tests which otherwise might require a very long time or not be undertaken at all.

SIMPLY "PLUG IN" BURROUGHS COINCIDENCE DETECTORS

Both of the coincidence detectors offered by Burroughs demonstrate the practical one-basic-function principle that makes Burroughs "Unitized" Pulse Control Equipment so suitable to your needs.

Burroughs Coincidence Detector, Type 1201B (shown here), is designed to detect coincidence between the output signal of a flip-flop and 0.1 microsecond pulses. Two inputs are provided for each unit. One accepts 0.1 microsecond pulses with amplitudes of 12 volts or more. The other accepts the output of Burroughs Flip-Flop, Type 1101C or equivalent.

Burroughs "Unitized" pulse control assemblies have been in constant use for more than two years. Their proved dependability has led to their use by many leading electronic research organizations, including: Massachusetts Institute of Technology, Consolidated Engineering Corporation, The Catholic University of America and Magnetics Research Company.

For full information on Burroughs "Unitized" Pulse Control Equipment, write or call Department 15F, Electronic Instruments Division, Burroughs Corporation, 511 North Broad Street, Philadelphia 23, Pa.

PULSE GENERATORS
COINCIDENCE DETECTORS
PULSE DELAYS
FLIP-FLOPS
PULSE GATERS
CHANNEL SELECTORS
MIXERS

ELECTRONIC INSTRUMENTS DIVISION
Burroughs
THE BEST KNOWN NAME IN OFFICE MACHINES

For more information circle **34** on inquiry card.

DEKORON IMPERVAPAK

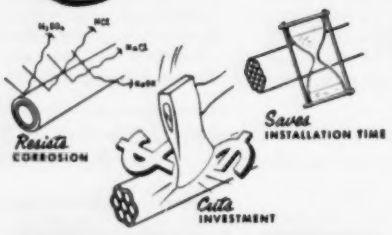
the instrument line harness that cuts tubing installation costs up to 50%

Worried about high instrument tubing installation costs? Then Dekoron Impervapak—the *corrosion-proof* instrument tubing harness—is just what the cost analyst ordered.

With Dekoron Impervapak there's no need to laboriously install instrument lines one at a time. Users say seven-tube Impervapak harness can be installed as rapidly as two single lines of ordinary instrument tubing. Savings are correspondingly greater with 10, 14 or 19-tube harness. Compact construction makes the installation neat and less subject to mechanical damage; no special brackets are needed.

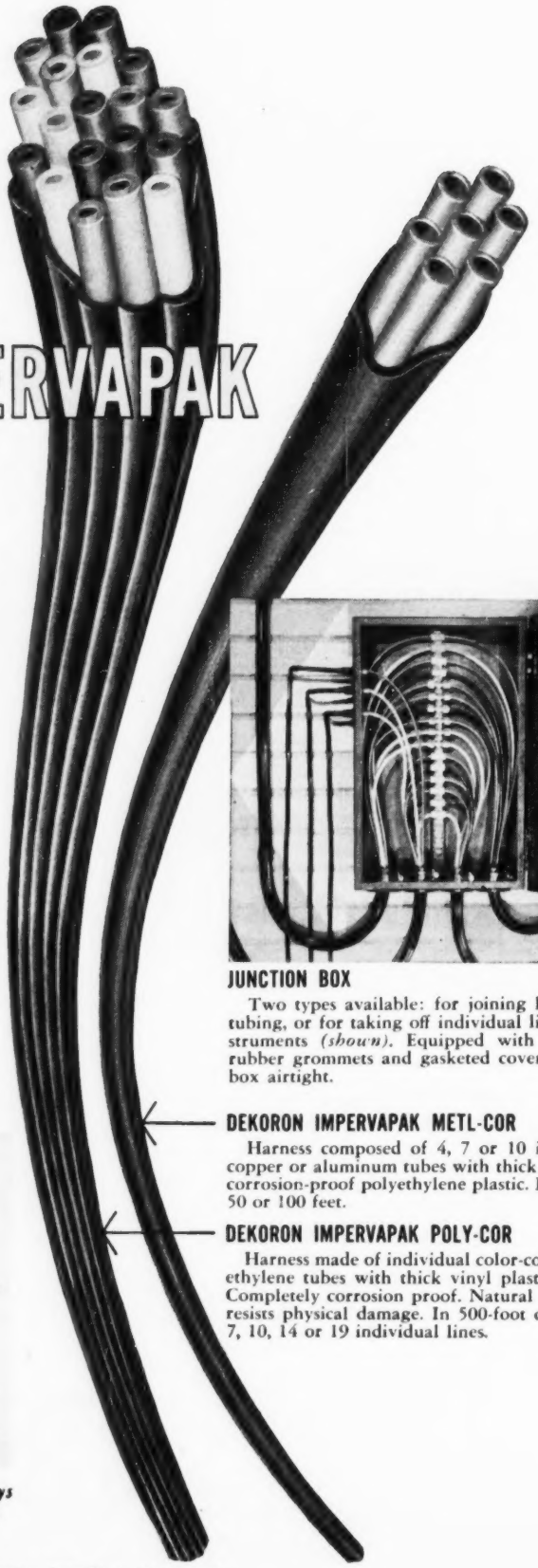
And perhaps most important of all, *Dekoron Impervapak is impervious to attack from even the most severe industrial atmospheres or weather conditions.*

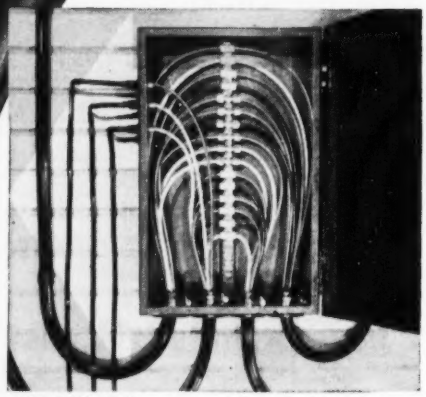
Dekoron® tubing



SAMUEL MOORE & COMPANY
DEKORON TUBING DIVISION • MANTUA, OHIO

Send for your free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."





JUNCTION BOX

Two types available: for joining lengths of tubing, or for taking off individual lines to instruments *(shown)*. Equipped with synthetic rubber grommets and gasketed cover to make box airtight.

DEKORON IMPERVAPAK METL-COR

Harness composed of 4, 7 or 10 individual copper or aluminum tubes with thick sheath of corrosion-proof polyethylene plastic. In coils of 50 or 100 feet.

DEKORON IMPERVAPAK POLY-COR

Harness made of individual color-coded polyethylene tubes with thick vinyl plastic sheath. Completely corrosion proof. Natural resiliency resists physical damage. In 500-foot coils of 4, 7, 10, 14 or 19 individual lines.

A-8438

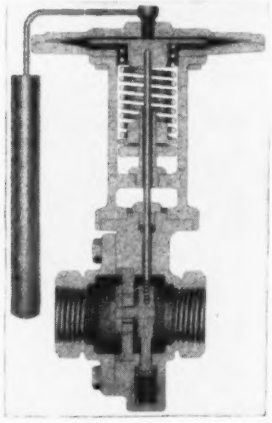
For more information circle **35** on inquiry card.

2.5 x 0.75 x 1.62 in. Mounting holes on 3⅛ in. centers. Operating temperatures to 550 F.; rating: 1500 watts, 115-230 v.ac.—*George Ulanet Co., 416 Market St., Newark 5, N. J.*

For more information circle **226** on inquiry card.

Temperature Controller

New "Figure 80 Temperature Control Valve" features reduction in number of moving parts by elimination of guide bushings and pistons.

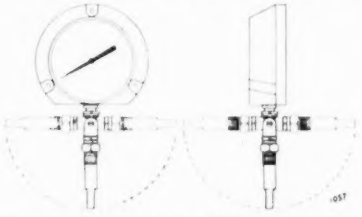


Positive shut-off is assured by self-lapping wiping action of sliding gate as it moves over orifice plate.—*Jordan Regulator Corp., Carew Tower, Cincinnati 2, Ohio.*

For more information circle **227** on inquiry card.

Adjustable-angle Dial Thermometer

New "Gotham Multi-Angle" dial thermometer can be rotated and tilted to any practical mounting angle and locked securely in position by a few

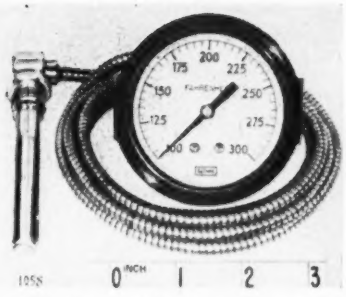


turns of one nut: positive-locking selector is so designed that vibration or strain has no effect on lock. All-stainless-steel thermal system, bronze-bushed movement, molded phenol case, black dial and white pointer. Available in all standard mercury ranges, in 4½, 6 and 8½-in. sizes with union connection or separable socket having ¾-in. or 1-in. male NTP.—*United States Gauge Div., American Machine and Metals, Inc., Sellersville, Penna.*

For more information circle **228** on inquiry card.

Dial Thermometers

New miniature mercury-actuated dial thermometers are 2.5 in. in diameter, with a bulb about half the length of a standard size bulb; are

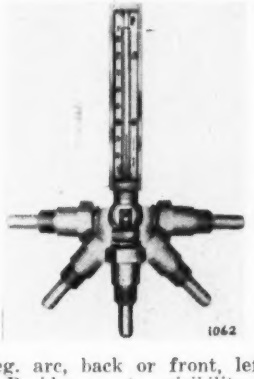


suitable for installation where previously only non-mercury actuated thermometers could be employed. Available in all standard ranges, with a variety of bulbs and connections. All-stainless-steel thermal system; bronze movement; drawn steel case with clamp for panel mounting.—*United States Gauge Div., American Machine and Metals, Inc., Sellersville, Penna.*

For more information circle **229** on inquiry card.

Adjustable-angle Industrial Thermometer

New "Midget Adjust-Angle" industrial thermometer with 5-in. case supplements maker's line of 7, 9 and 12-in. case size instruments that can be positioned to any angle through a



180-deg. arc, back or front, left or right. Besides greater visibility, ease of angle change simplifies maintenance and spare stock requirements. Owing to flexible connection, danger of breakage due to shock or vibration is minimized. Available in all ranges to 750 F., with all standard fittings.—*Weksler Thermometer Corp., 49 W. 32nd St., New York 1, N. Y.*

For more information circle **230** on inquiry card.

PRESSURE AND LOAD

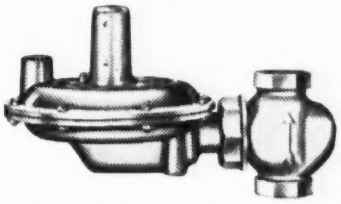
Pressure-failure Shut-off

New automatic shut-off device for pressure failure in pneumatic systems locks control valves in a pneumatic system in event of lowering of air pressure, prevents valves and other devices from going wide open or closed. Spring-loaded diaphragm has supply pressure on one side and system pressure on the other: lowering or failure of supply pressure unbalances diaphragm to close needle valve in control line.—*Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.*

For more information circle **231** on inquiry card.

Gas Pressure Regulators

New "Series 1400 Reliance Regulators" for low-pressure installations are particularly suited to applications where distribution systems are con-

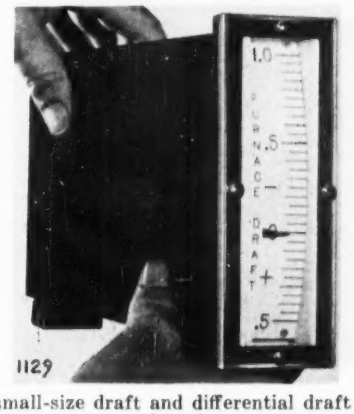


verted from low to high pressures; feature ease of installation and mounting in any position through incorporation of a union type removable pipe section. Maximum inlet pressure 75 psi. Optional built-in mechanical relief valve is set to relieve at approx. 14 in. water.—*American Meter Co., 1513 Race St., Philadelphia 2, Pa.*

For more information circle **232** on inquiry card.

Draft or Differential Gage

New "Bantam Gauge" for measuring draft, pressure, vacuum, or differential draft is said to be the first

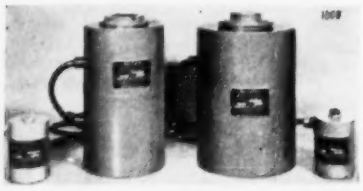


small-size draft and differential draft type gage complete in one case: no transmitters or accessory mechanisms are needed. Bezel is 6.44 in. high; up to eight gages may be mounted in a single case. Illumination from rear by incandescent or fluorescent bulbs. Full-sized diaphragms or bellows are used. Diaphragm elements available for pressure ranges as low as 0.6 in. and as high as 40 in. of water. With bellows elements, gage may be used as a receiver for pneumatic transmission pressures between 5 and 30 psi. It can also be furnished with two bellows and two pointers for steam flow-air flow or fuel-air indication.—*Republic Flow Meters Co., 2241 Diversey Parkway, Chicago 47, Ill.*

For more information circle **233** on inquiry card.

High-accuracy Load Cells

New series of "precision" and "extra precision" bonded-resistance-wire-type "SR-4" load cells for measuring forces and weights include 18 compression load cells ("Type CX and CXX") in nine capacities from 500 to 200,000 lbs., and 16 tension load cells ("Type TX and TXX") in eight capacities from 500 to 100,000 lbs. New cells are mechanically and elec-



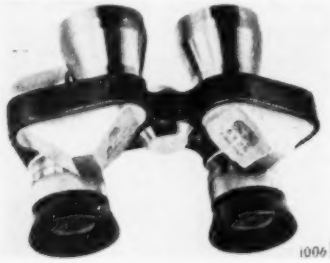
trically interchangeable with standard cells: same 120-ohm nominal resistance, same 2 mv./v. voltage output at rated capacity. Difference is finer tolerances to which new cells are calibrated and temperature-compensated.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **234** on inquiry card.

OPTICS

Binocular

New "Broadfield" binocular was developed after analysis of questionnaires: over 40 classes of expert, professional and constant users of bi-

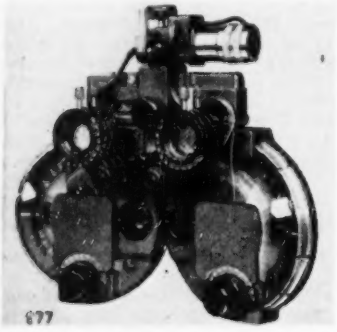


noculars, and 32 types of occasional users, were consulted. "Broadfield" has 600-ft. field at 1000 yds., 6-power magnification, 25-mm. objective aperture. Prisms and achromatic lenses are anti-reflection abrasion-resistant hard coated.—*Bushnell Optical Corporation of America, 240 Bushnell Bldg., Pasadena 1, Calif.*

For more information circle **235** on inquiry card.

Phoroptor Illuminator

New illuminator for "Model 590 Phoroptor" can be installed in units now in use or be ordered as factory-



installed equipment on new units. It illuminates scales, making it easier to operate in darkened offices.—*American Optical Co., Southbridge, Mass.*

For more information circle **236** on inquiry card.

Magnifying Glass

New self-focusing magnifying glass enlarges reading material to double size, is rectangular in shape to permit reader to see a complete line at a glance, without distortion. It rests on reading matter, need not be held in hand, is merely slid from line to line down the page. It is extruded from transparent plastic into an H-shaped cross-section of varying lengths: 3, 6, 9 and 12-inch sizes standard, but any length can be furnished. Design protects lens at all times.—*J. B. Schrell Corp., 300 S. Los Angeles St., Los Angeles 13, Calif.*

For more information circle **237** on inquiry card.

FOR THE LABORATORY

Grain-size Comparator

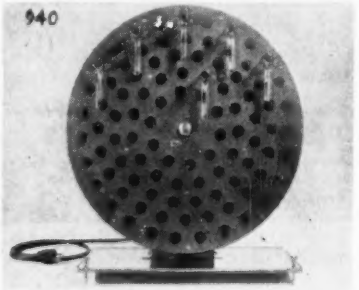
New "Micrographex Comparator" is for determination of grain size in copper and copper-base alloys from

0.01 mm. to 0.20 mm. as classified by ASTM E79; can also be used for various particle-size determinations.—*General Scientific Equipment Co., 3011 Dixwell Ave., Hamden 14, Conn.*

For more information circle **238** on inquiry card.

Rotor Unit for Cultures

New rotor unit for roller tube cultures has driving mechanism integral with rotor supports and indexing reel

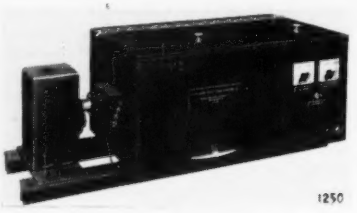


at one revolution per 6 min. Reel holds 94 culture tubes in five concentric circles. Advantage over usual methods: accommodating larger tissue mass. Unit permits radioassay of tracers through culture tube; can be placed in standard incubators.—*Microschemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.*

For more information circle **239** on inquiry card.

Light-scattering Photometer

New "1000 Series Brice-Phoenix Universal Light Scattering Photometer" measures absolute turbidity, dis-

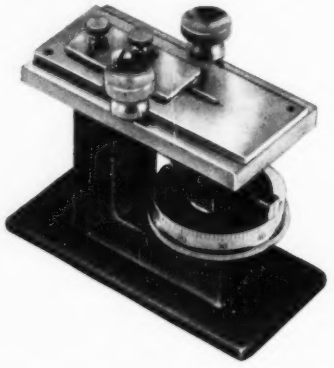


symmetry, and depolarization of dilute solutions of high-molecular-weight compounds; enables determining average linear dimensions of molecule and classifying solute molecules for size and anisotrophy; permits rapid following of changes in molecular weight, particle size and anistrophy; can also be used for measurement of specular and diffuse transmittance, reflectance, and fluorescence. Among features: multiplier-phototube receiver; light source is AH3 mercury lamp with 0.436- and 0.546-micron filters; automatic voltage regulation to 0.1 volt for phototube and light source; galvanometer with 0.001 ua./mm. sensitivity; demountable polarizer and analyzer; reference and working standards; dissymmetry cell for 45, 90 and 135 deg.; three square optical cells—all included; but instrument will accommodate various other cells.—*Phoenix Precision Instrument Co., 3803 N. 5th St., Philadelphia 40, Pa.*

For more information circle **240** on inquiry card.

Fiber Microtome

New model of maker's fiber microtome makes possible rapid preparation of extremely thin sections for study of fibers, threads, yarns, plant

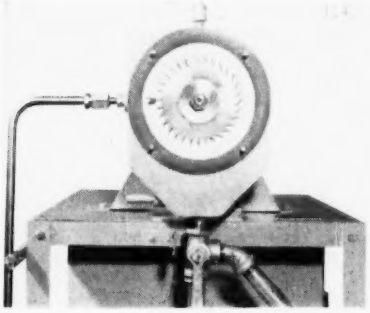


stems, films, paper, etc., for laboratory and commercial analysis where speed and accuracy are of importance. It has been improved by: (1) new tongue design, much sturdier than old, permits more rapid packing of fibers to be examined; (2) hard-chrome finish on top plate, assures a smooth, hard reference surface that makes it easier for operator to section fibers. Drum has 10-micron divisions.—*Mico Instrument Co., 80 North Trowbridge St., Cambridge 38, Mass.*

For more information circle **241** on inquiry card.

Mechanohydraulic Mill

New laboratory model of "Rafton Mill" features tremendous hydraulic shock to material under investigation: the teeth of a very-high-speed circu-

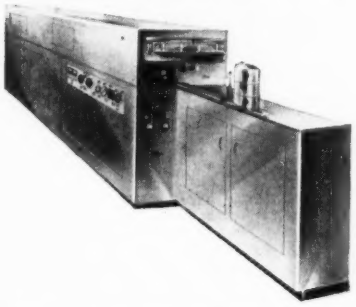


lar saw strike with terrific blows a jet of liquid projected into their path. Examples: (1) if liquid be a flowable suspension carrying solid particles, physical characteristics of solid particles may be changed; (2) if liquid be an organic reaction mixture, reaction rate may be speeded up; (3) if liquid contain a high-molecular-weight organic substance, structure of substance may be altered.—*Rafton Engineering Corp., P. O. Box 8, Andover, Mass.*

For more information circle **242** on inquiry card.

Plane-grating Spectrograph

New "JAco Plane Grating Spectograph," first instrument of its type to become commercially available, is said to offer special advantages in analyzing isotopes, in study of line



shapes, or in any analysis problem involving high dispersion or low concentration. It is completely stigmatic and has been specifically developed to produce ultra-high dispersion and resolution while covering 2000A to 6500A at a single setting. Theoretical resolving power ranges from 75,000 in first order to 600,000 in eighth order. Resolution is guaranteed to be 100,000 at 3000A. Practical speed equals that of maker's "Wadsworth Grating Spectrograph." Standard spectograph is supplied with a 20-in. plateholder to accommodate two 4x10-in. plates. In first order, when a standard 15,000 line/inch ruling is used, plates cover 2200-4700A in a single continuous spectrum at at dispersion of 5A/mm. (most useful for all-purpose work). For routine quantitative work a shorter range can be readily obtained by employing a single 10-in. or shorter plate in the 20-

Official U. S. Navy Photograph

At battle stations, the actions of every man and instrument must . . .

synchronize!

Modern warfare demands the ultimate in teamwork between men and instruments. Every instrument must not only perform with scientific precision, but must be easy *to read and interpret.*

That's the advantage of U. S. Radium dials and edge-lighted panels. They are "human-engineered" for accurate, at-a-glance readings. Their clean, functional design makes any instrument more seeable, more valuable, more saleable.

Whatever your requirements—for dials, edge-lighted panels, or nameplates – whether luminescent or nonluminescent – and in whatever materials or finishes you desire—you name it, we make it. Get the finest—U. S. Radium. Write or phone for complete information. Dept. I-12, U. S. Radium Corp., 535 Pearl Street, New York 7, N. Y.

MAKERS OF: Luminescent Materials: Radioactive, fluorescent, phosphorescent • Powders: Cathode-ray tube, television tube • Radium Locators: Pendants, lenses, buttons, screws, markers • Static Eliminators • Radioactive Foils – Alpha-Ray Ionization Sources • X-Ray Screens • Processed Isotopes • Neutron Sources.

DIALS • NAMEPLATES • EDGE-LIGHTED PANELS

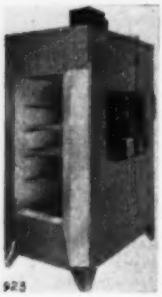
For more information circle **16** on inquiry card.

in. plateholder. For unusual applications a 30-in. plateholder can be provided, covering a 3750A range in first order. Actual range changes are made by rotating grating. Two other gratings are available for extraordinary applications: 7500 and 30,000 line/inch. Spectograph has push button controls for shutter, wave-length and plate-racking mechanism (spectra 1, 2, or 3 mm. apart). Adjustable or fixed slits optionally available. —*Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.*

For more information circle **243** on inquiry card.

Cabinet Oven

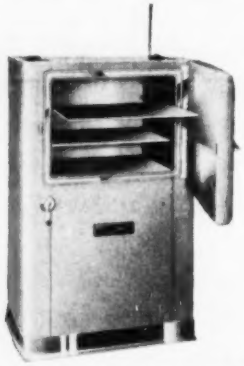
New "Standard-Model Vertical Flow Oven" is said to have features which reduce heat loss with corresponding greater efficiency and lower operating cost: no metal-to-metal contact; double gasketed doors with heat trap; 20 percent more insulation; high-low selective heat intensity control. A high-pressure blower propels heated air in a definite air-flow pattern through work chamber, preventing disturbance due to radiant heat and assuring temperature uniformity. Components readily accessible. Two sizes: work space 26x26x38 in. and 26x30x50 in. Temperatures 650 or 850 F. Variations from standard can be made.—*Grieve-Hendry Co., Inc., 1811-19 W. Lake St., Chicago 12, Ill.*


923

For more information circle **244** on inquiry card.

Controlled-air-flow Ovens

New "Force-Aire Bench-Saver Ovens" feature controlled temperatures up to 270 C. (520 F.) with 3-way variable air flow. Three sizes,



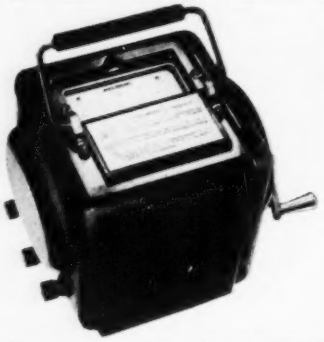
all floor models. Heaters are Inconel sheathed; dual door gaskets are made of Silicone rubber; interiors are stainless steel. Blower provides uniform air velocity working chamber through baffled perforated walls; air velocity can be regulated from 75 to 250 fpm. Thermostat is U. L. approved.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **245** on inquiry card.

FOR THE TESTING DEPARTMENT

Insulation Tester

New "Model 5G-1000 Megohmmeter" is an improved insulation resistance test set that can withstand rugged field use. Improvements in-

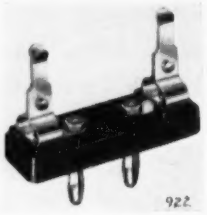


clude rugged casing and components, easier drive mechanism, free-wheeling generator clutch, and separate Alnico magnets for indicator and generator. "Model 5G-1000' reading to 1000 megohms, 500-volt self-powered, meets MIL-M-15023. Other models.—*The Winslow Co., 9 Liberty St., Newark, N. J.*

For more information circle **246** on inquiry card.

Clips-and-plugs Test Unit

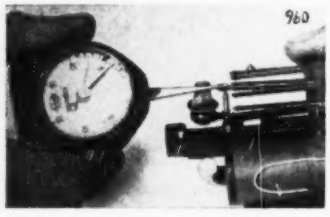
New "No. 2-2 Test Board" is a modification of maker's panel mount test clips, designed to simplify testing of resistors, capacitors, germanium diodes, etc.; has banana plugs on ¾-in. centers. Plugs and clips are plated. Same spring clips are used as on maker's Test Clips—a perfect contact is claimed at all times. —*Grayhill, 561 Hillgrove Ave., La Grange, Illinois.*


922

For more information circle **247** on inquiry card.

Small Dynamometer

New "Precision Dynamometer" for measuring spring tension, starting torque, etc., features extra maximum-indicating hand; is available in two

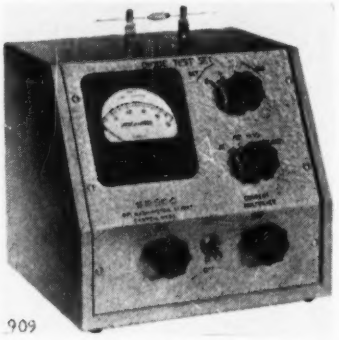

960

models, each acting in both directions. "Small model" in ranges 5-15, 5-30, 10-50, 20-100, 25-150 grams; "large model" 25-250, 50-100, 100-1000 grams.—*George Scherr Company, 200 Lafayette Street, New York 12, N. Y.*

For more information circle **248** on inquiry card.

Transistor & Rectifier Tester

New "Model D102 Diode Test Set" can be used not only for testing miniature or power germanium and se-

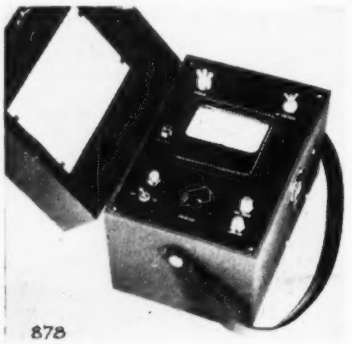

909

lenium rectifiers, but also for determining transistor parameters—for laboratory development purposes, in production quality control, and in system maintenance.—*Electronics Production Service Co., 871 Washington St., Canton, Mass.*

For more information circle **249** on inquiry card.

High-voltage Tester

New "Model 422 Hypot Junior" features visual indication of electrical leakage and breakdown; continuously variable voltage output to 10,000

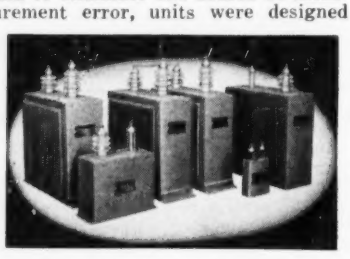

878

volts; and a kilovoltmeter (connected directly across h-v. output) accurate to 3 percent of full scale regardless of load characteristics. Input is 115-volts 60-cycle a.c.—*Associated Research, Inc., 3766 W. Belmont Ave., Chicago 18, Ill.*

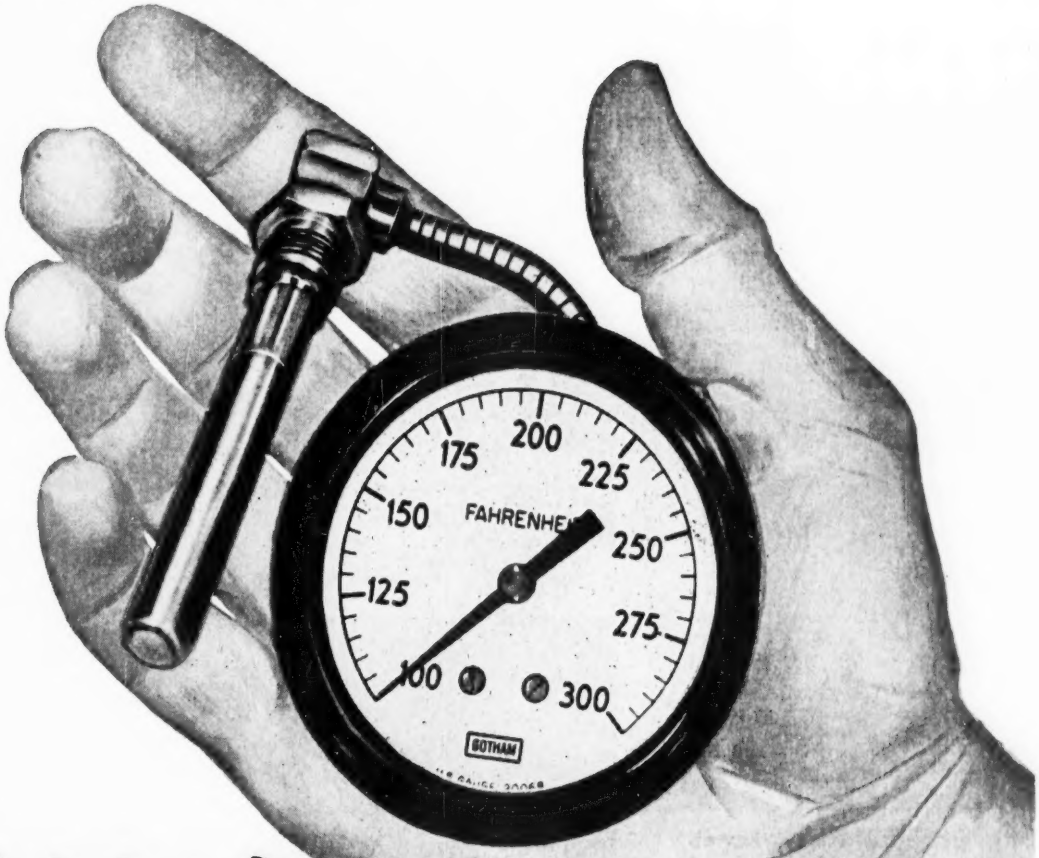
For more information circle **250** on inquiry card.

Tube-testing Networks

New Pulse-Forming Networks are for use in testing various types of hydrogen thyratron tubes. To compensate for self-inductance usually inherent in tube-testing equipment and to eliminate one source of measurement error, units were designed



MINIATURE IN SIZE...



GIANT in performance

The dial of this Gotham "Miniature" Mercury Dial Thermometer is only 2½" in diameter, but everything else about it is large-scale. Built for those applications where panel and mounting space are at a premium, it gives you all the accuracy, sensitivity and durability you could ask for.

The entire thermal system is stainless steel with a bulb only half the size of a standard bulb. This small bulb length now enables you to obtain the ruggedness and reliability of mercury actuation in places where only non-mercury actuated thermometers could be used before.

A linear dial—with uniform graduations over a 270° arc—permits precise temperature readings at a glance.

If your application requires a remote reading, quality dial thermometer with hairline sensitivity, constant accuracy and dependability mounted in a small space, the Gotham "Miniature" is your answer. It's designed to give top performance under the most severe operating conditions.

The Gotham line of Mercury Dial Thermometers also includes thermometers in 3½", 4½", 6" and 8½" sizes to suit every type of industrial service. Write today for full information. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

FEATURES:

Thermal System	Stainless Steel
Movement	Corrosion-resistant Brass
Dial	Black or white with contrasting figures and graduations
Case	Drawn Steel
Ring	Brass Friction Fit
Mounting	U-shaped clamp assembly
Connection	Center back with ½" NPT bulb connection
Ranges	All standard Mercury Dial Thermometer ranges
Accuracy	1% of full scale range over middle half of dial.

Quality Gauges Engineered for Enduring Accuracy

USG UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

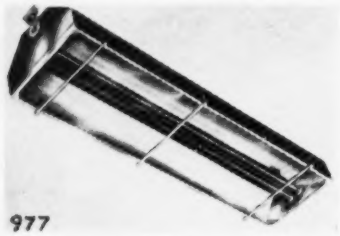
For more information circle **37** on inquiry card.

with input inductance less than the values theoretically required for such applications. Suitable under U. S. Signal Corps tube testing program, units are available for five standard thyratron tube types: 3C45, 4C35, 5C22, 1902, and 1907.—*Sprague Electric Co., 199 Marshall St., North Adams, Mass.*

For more information circle **251** on inquiry card.

UV Inspection Lamps

New improved "Blak-Ray" (black-light) lamps are designed for difficult inspection procedures, flaw detection, control, processing, etc., requiring a much more optically correct source and reflector than found in conventional fixtures. New lamps burn cool, start and restart with no warm-up or cooling-off period required. Replaceable tubes last 3000-6000 hours. Units range in size from 4 to 120 watts.—*Ultra-Violet Products, Inc., South Pasadena, Calif.*

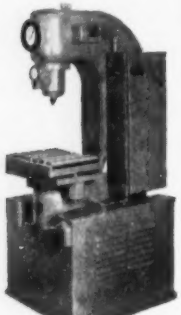


977

For more information circle **252** on inquiry card.

Automatic Hardness Tester

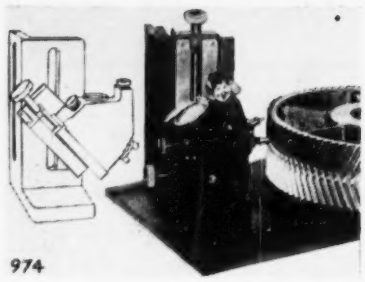
New "Model KDR-10X Brinell Hardness Testing Machine," designed to fit into a conveyor system, is adapted from maker's standard hydraulically-operated direct-reading tester; features a roller conveyor arranged in conjunction with tester's "anvil," which consists of a series of hardened steel bars affixed to lower portion of C-frame. Between these bars are interspersed conveyor rollers, which are lowered and raised automatically during testing cycle. An electric timer holds load for a selected interval, after which penetrator raises; conveyor raises; and operator rolls part off.—*Steel City Testing Machines, Inc., 8817 Lyndon Ave., Detroit 21, Mich.*



For more information circle **253** on inquiry card.

Hardness Tester

New "Penetrascope Multiple Angle Metal Hardness Tester" was developed for testing parts and places inaccessible when clamps are employed; is also adaptable as a conventional bench-type hardness tester. It comprises a modified portable "Penetrascope" movably mounted on a slotted stand whose base contains electromagnets which hold unit firmly to a layout table or other ferrous base. Photo shows tester set in horizontal position; drawing shows tester rotated on its stand.—*C. Tennant, Sons & Co., 100 Park Ave., New York 17, N. Y.*

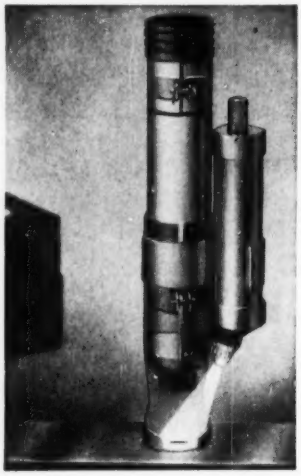


974

For more information circle **254** on inquiry card.

Brinell Microscope

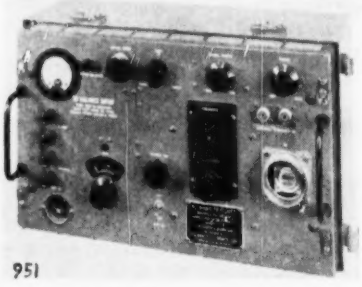
New Brinell microscope reader, for measuring diameters of indentations made by ball indenters of all Brinell type hardness testers, features a reticle scale 7.0 mm. long, calibrated in millimeters and tenths. Magnification is 20×.—*Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles, Calif.*



For more information circle **255** on inquiry card.

KU-band Signal Generator

New "KU Band Signal Generator" provides means for complete testing of radar or associated equipment in 15.75-16.25 kMc. range; comprises a reflex klystron tube and associated plumbing as well as necessary attenuating devices and an absorption type wavemeter. Internal modulation circuitry tube provides both pulsed and FM modulation of klystron oscillator. A temperature-compensated thermistor bridge is incorporated for measuring both power output of oscillator and RF input for testing of transmitters. All necessary power supplies are built in.—*Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.*

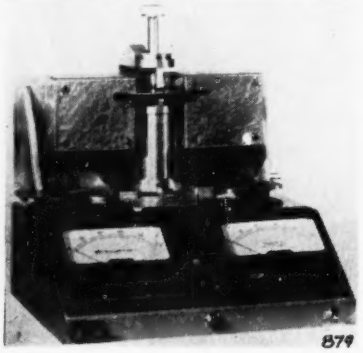


951

For more information circle **256** on inquiry card.

Ball-bearing Tester

New "Baker-United Air Lines Ball Bearing Torque Tester" is for comparing break-away, starting and running torque, evaluating race roughness and dirt. One control enables operator to smoothly raise voltage on an eddy current motor until it just starts the bearing. One indicator then gives a comparative measure of starting torque while at reduced voltage a steady-state running torque is shown. On another indicator, at a selected speed, amplified signals generated by race roughness and dirt indicate bearing quality.—*The Baker Co., Inc., Maplewood, Maine.*

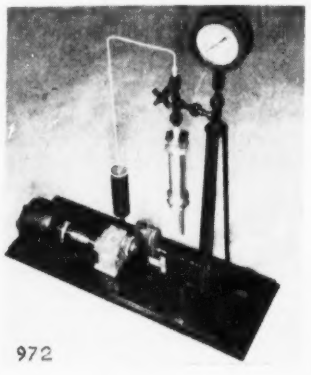


879

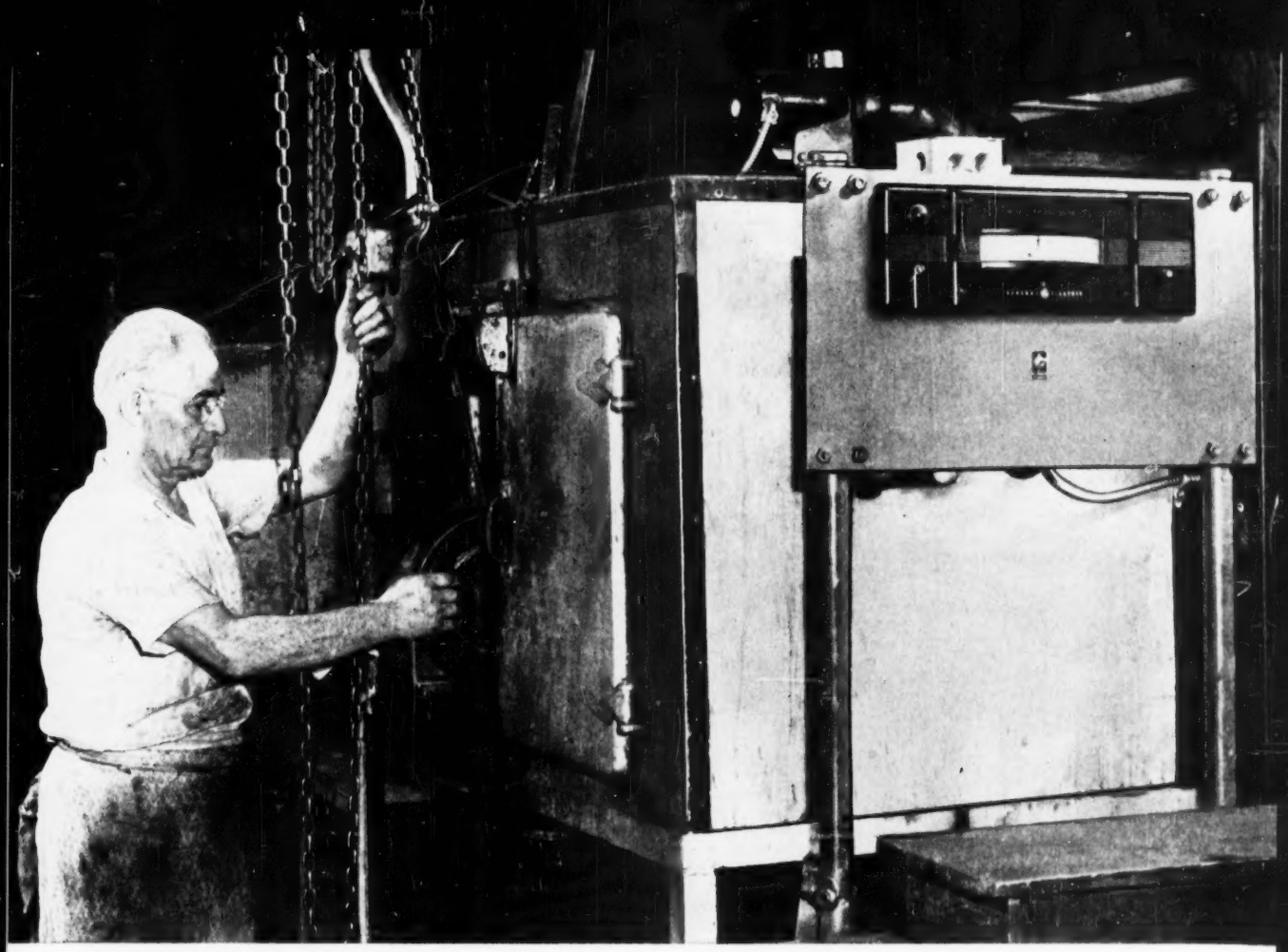
For more information circle **257** on inquiry card.

Grease Viscometer

New "Grease Pressure Viscometer" meets all requirements of ASTM D-1092, all similar Federal and Armed Forces Grease Viscometer specifications, is suitable for all tests and research involving viscosity of greases under varying shear rates and temperatures. Hydraulic system comprises a ¼-hp. heavy-duty motor, a

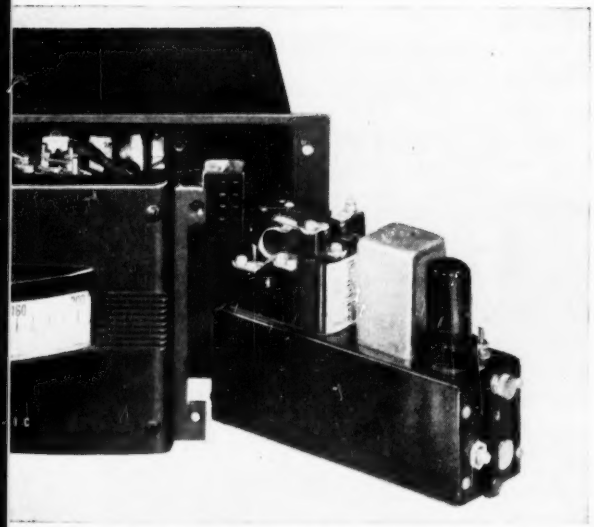


972



G-E PYROMETER-CONTROLLER ASSURES EVEN TEMPERATURES IN BAKING OF MOTOR STATORS—HELPS REDUCE REJECTS

Improve Product Quality, Reduce Rejects with G-E Precision Pyrometer-Controllers



PLUG-IN CONTROLLER UNIT pulls out easily for convenient maintenance checking. Standard vacuum tube may be replaced at low cost at any radio-tube supply store.

Excessive overheating costs you money—as production rejects increase and your product's quality drops.

General Electric pyrometer-controllers offer you a low-cost way (prices start at $215.78*) of maintaining even furnace temperatures despite changes in voltage or ambient. This precision control can help you to reduce rejects, and hold the line on product quality.

HIGH SENSITIVITY of G-E controllers means that any change in temperature equal to 2/10 of 1% of full scale is enough to initiate control action.

This line of HP controllers is accurate to 3/4 of 1% of full scale.

SEVERAL TYPES AVAILABLE, including indicators, indicator controllers, and protectors—in either 2-position or 3-position models. Scale requirements can be fulfilled from a variety of ranges in the 0-3000F span.

FOR COMPLETE INFORMATION, contact your G-E Apparatus Sales Office, or write for Bulletin GEC-713 to General Electric Company, Schenectady 5, N. Y. 602-264

*Manufacturer's suggested retail price.

GENERAL ELECTRIC

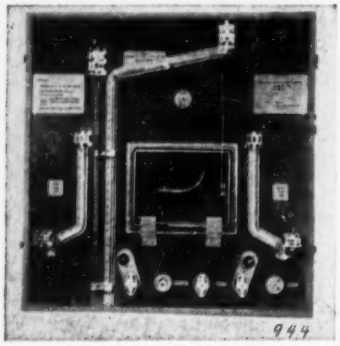
For more information circle 38 on inquiry card.

200:1 speed reducer, a powerful pump, and extra-heavy-duty pipe connections. Four pressure gages: 50/100/-500/2000-psi. ranges. Three grease chambers and eight capillaries, machined to better than ASTM requirements.—*Technical Equipment Co.*, 743 *Dwight Way, Berkeley* 10, *Calif.*

For more information circle **258** on inquiry card.

Oxygen Regulator Tester

New "Model OTS-562" oxygen-regulator test stand was developed for testing aircraft diluter-demand oxygen regulators: it determines per-



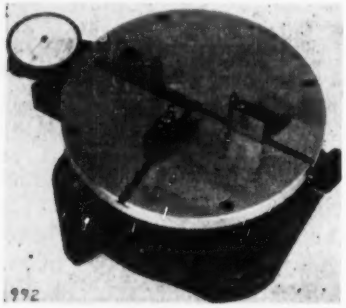
formance of regulator as regards flow-rate, air-oxygen proportioning, actuating suction, leakage rates, and oxygen delivery pressure at high altitudes. Flow-rates are measured by two "Vol-O-Flo" meters (essentially independent of altitude) with ranges from 0 to 165 liters per minute. A 50,000-foot altimeter is provided. —*National Instrument Labs., Inc.*, 6108 *Rhode Island Ave., Riverdale, Maryland.*

For more information circle **259** on inquiry card.

FOR INSTRUMENT SHOP

OD and ID Comparator

New "K7-R Bench Comparator" gages inside or outside diameters on short or production runs. Illustrated

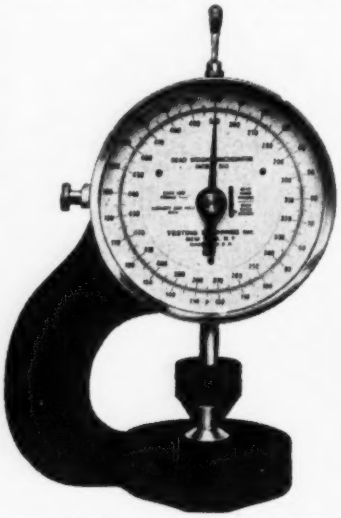


is "T" plate type with adjustable ID and OD jaws. Several other types of jaw arrangements are available, with jaws made to specific requirements. —*Acra-Ment, Gage Div., Myer Corp.*, 633 *Park Ave., Cranston, R. I.*

For more information circle **260** on inquiry card.

Double-duty Micrometer

New "Model 553" measures up to 0.500 in. in 0.001-in. divisions. Its 6-in. dial includes a simple zero adjustment and permits reading half-divi-



sions. "Model 553" is available with different dead weights and anvil sizes; can be made to conform to ASTM and other specifications.—*Testing Machines, Inc.*, 123 *W. 64th St., New York, N. Y.*

For more information circle **261** on inquiry card.

Midget Torque Screwdriver

New "Model J" midget factory-set torque screwdriver has interchangeable handle, can be supplied with a jeweler's finger guide (illustrated)

or a knurled type. Among advantages: tool takes all responsibility from assembler; no friction clutch; positive locking and unlocking.—*Overload Control Co.*, 260-11 *Langston Ave., Glen Oaks, L. I., N. Y.*

For more information circle **262** on inquiry card.

Granite Surface Plate

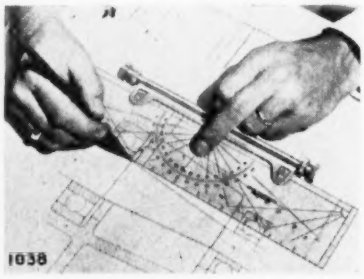
New line of grey granite surface plates supplements maker's line of premium black granite in order to meet demand for lower price basis.

Accuracies are the same. Sizes from 12 x 18 in. to 48 x 72 in.; 2- and 4-clamp edge types.—*Collins Microflat Co.*, 2326 *E. 8th St., Los Angeles* 21, *Calif.*

For more information circle **263** on inquiry card.

Drawing Instrument

New "Paraline" combines functions of T-square, triangles, straight-edge, scales and protractor, or drafting ma-

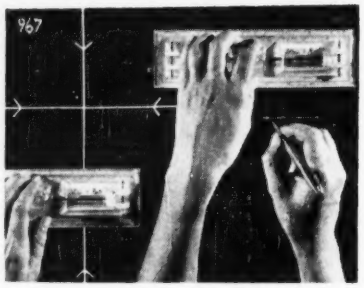


chine, in one unit without adjustments or additional parts; weighs less than 4 oz. and is small enough to carry in pocket or brief case (12½x3½ in.). "Professional Model" available in either engineer's scale or architect's scale; "Standard Model" is architect's scale only.—*Pickett & Eckel, Inc.*, 5 *S. Wabash Ave., Chicago* 3, *Ill.*

For more information circle **264** on inquiry card.

Drawing Instrument

New "Glide-Rule" is a transparent drawing instrument capable of rolling in two directions, which combines triangles, T-squares, straight edge,

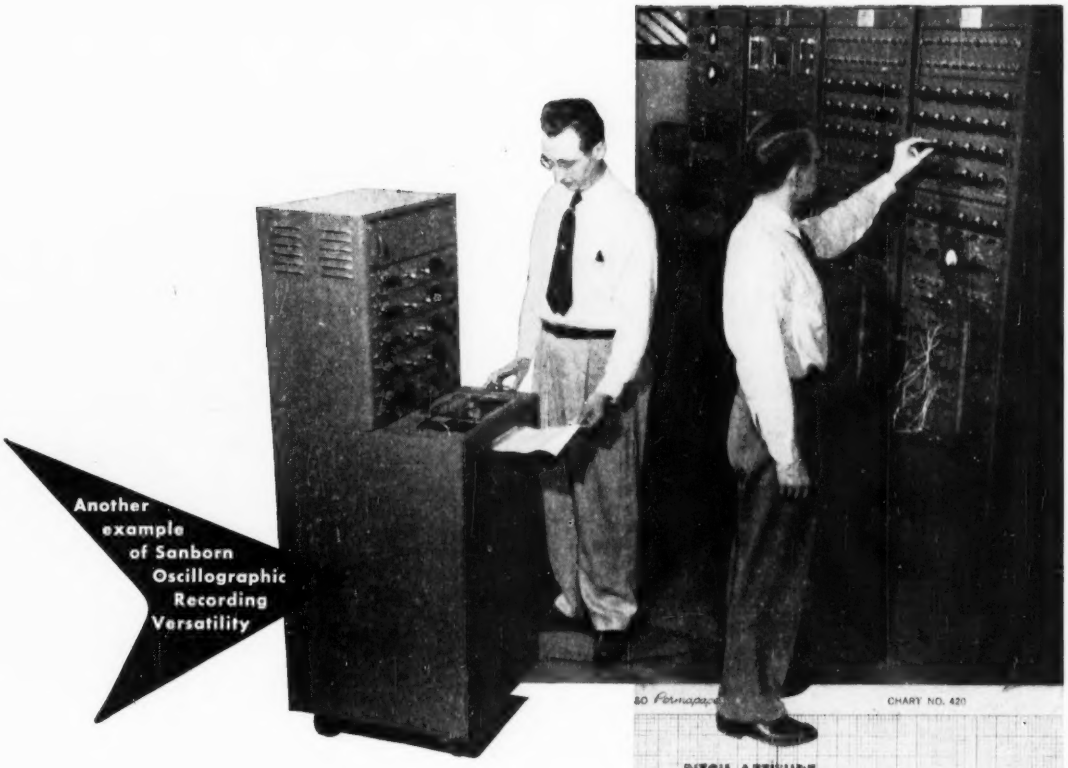


scales, protractor and parallel rules. It has four drawing edges with scales in 16ths and 20ths; 180-deg. protractor has emphasized 30, 45 and 60-deg. angles. Instrument rolls both up and down and right and left; a small thumb button permits user to change direction.—*Smith Drake Corp.*, 1206 *South La Brea Ave., Inglewood, Calif.*

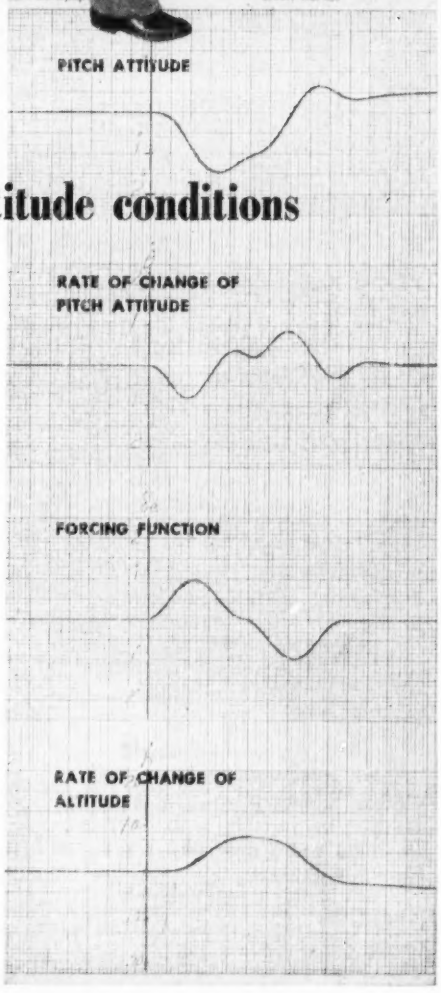
For more information circle **265** on inquiry card.

Surface-quality Indicator

New "Type QA Amplimeter," for use with all "Profilometer" equipment in measuring surface roughness, shows either rms. or arithmetical average roughness height, in micro-



Four-channel recording correlates simulated jet bomber airspeed and altitude conditions



At Eclipse-Pioneer, engineers make good use of Sanborn 4-channel recording systems in conjunction with high precision analogue computers to establish performance criteria for automatic flight systems and components.

At other laboratories Sanborn Systems are being used to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation and tension.

SANBORN OSCILLOGRAPH RECORDING SYSTEMS HAVE MANY APPLICATIONS. They are used in a great many different fields where accurate and permanent graphic registration of almost any electrical phenomena (whose frequency range is zero to 100 cycles per second) is required.

Sanborn Systems are widely used because of the availability and ready interchangeability of amplifiers and preamplifiers, as well as such Sanborn advantages as: inkless recording in true rectangular coordinates, high torque movement, time and code markers and wide choice of paper speeds. In addition, a basic choice of systems, 1-, 2-, and 4-channels, provides a system to fulfill almost any laboratory requirements.

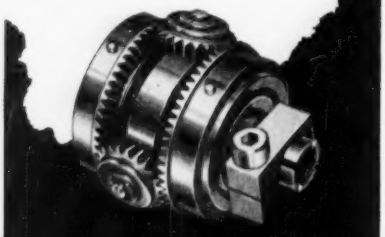
WRITE FOR CATALOG

Sanborn Company
INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS, U.S.A.

For more information circle **39** on inquiry card.

Hollow Shaft Differential

Minimum weight, inertia, and backlash. A precision computer component. Designed for accurate resolution of angular position or velocity sums and differences. Hollow shaft design offers complete freedom of positioning of differential on shaft and facilitates installation-removal of differential from shaft without instrument disassembly. Shrink-on, safety-keyed side gears available to your specifications. Inertia: .0745 ounce-inch^2; maximum backlash: 10′; overall axial length: 1$\frac{3}{16}$″; clearance radius: .520″; weight: 1¼ ounces; unit receives a $\frac{3}{16}$″ diameter shaft. Precision ball bearings.



application versatility
in
computer components
by

LIBRASCOPE
INCORPORATED

The functional solution to your computing and controlling problem is available at Librascope, where design simplicity keynotes 15 years of leadership in industrial control.

For details on this and other computing-controlling components, write:

LIBRASCOPE, INC.

Mechanical and electrical analog computers, digital computers, input-output devices and components.

1607 FLOWER STREET, GLENDALE, CALIF.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **40** on inquiry card.

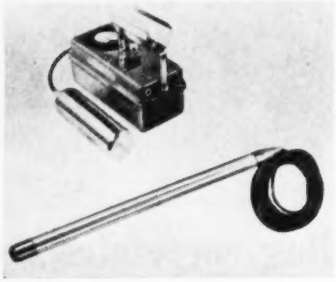
inches, as selected by a switch on panel. It conforms to proposed new ASA Standard B46.1 as regards all technical details. It is not sensitive to mechanical shock or vibration, has a 30-second warmup, and is not affected by normal temperature changes or by line voltage fluctuations from 90 to 130 volts. No sensitivity adjustment; no calibration by operator; accuracy readily checked by tracing a rated roughness specimen furnished as standard equipment.—*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*

For more information circle **266** on inquiry card.

NUCLEONICS

Scintillation Counters

New "Fission Finder" scintillation survey meter, and "Fission Tackle" scintillation drill hole probe-type radioactivity detector, are scintillation

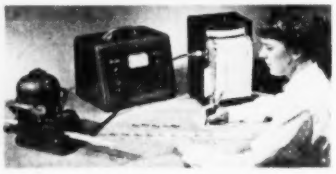


counters for uranium and oil prospecting surveys; are gamma-sensitive and are approx. 100 times more sensitive than average Geiger counter.—*Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.*

For more information circle **267** on inquiry card.

Automatic Scanner for Paper Radiochromatograms

New "Actigraph" fully-automatic system for exploring distributed radioactivity on paper radiochromatograms locates and estimates quantita-



tively the components separated on the chromatogram by systematically scanning the paper strip with a thin-window Geiger counter. Movement of paper strip is synchronized with that of recording chart so that a direct comparison may be made. Selection of eight speeds from 0.75 to 360 in./hr. Special tables permit instrument's use as a simple sample changer or with absorbers to produce a characteristic absorption curve—*Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **268** on inquiry card.

Gamma-ray Detector and Prospecting Counter

New "Model V Counter" is a pocket-size uranium-prospecting instrument and gamma-ray detector

using three low-voltage counter tubes, transistor amplification, and headphone indication. It operates from small batteries inside instrument, without use of any charging device. Feature is use of maker's "Varilytic" counter tubes: unlike Geiger tubes their operating voltage is not critical and they do not require a current-limiting resistor in circuit. Background counting rate is about 18 to 25 counts per minute at sea-level, low enough to count by ear. Maximum intensity limit is about 5 to 8 milliroentgens per hour—in excess of any prospecting need. Electric circuits are tropicalized.—*Western Radiation Laboratory, 1107 West 24th St., Los Angeles 7, Calif.*

For more information circle **269** on inquiry card.

Neutron Flux Counters

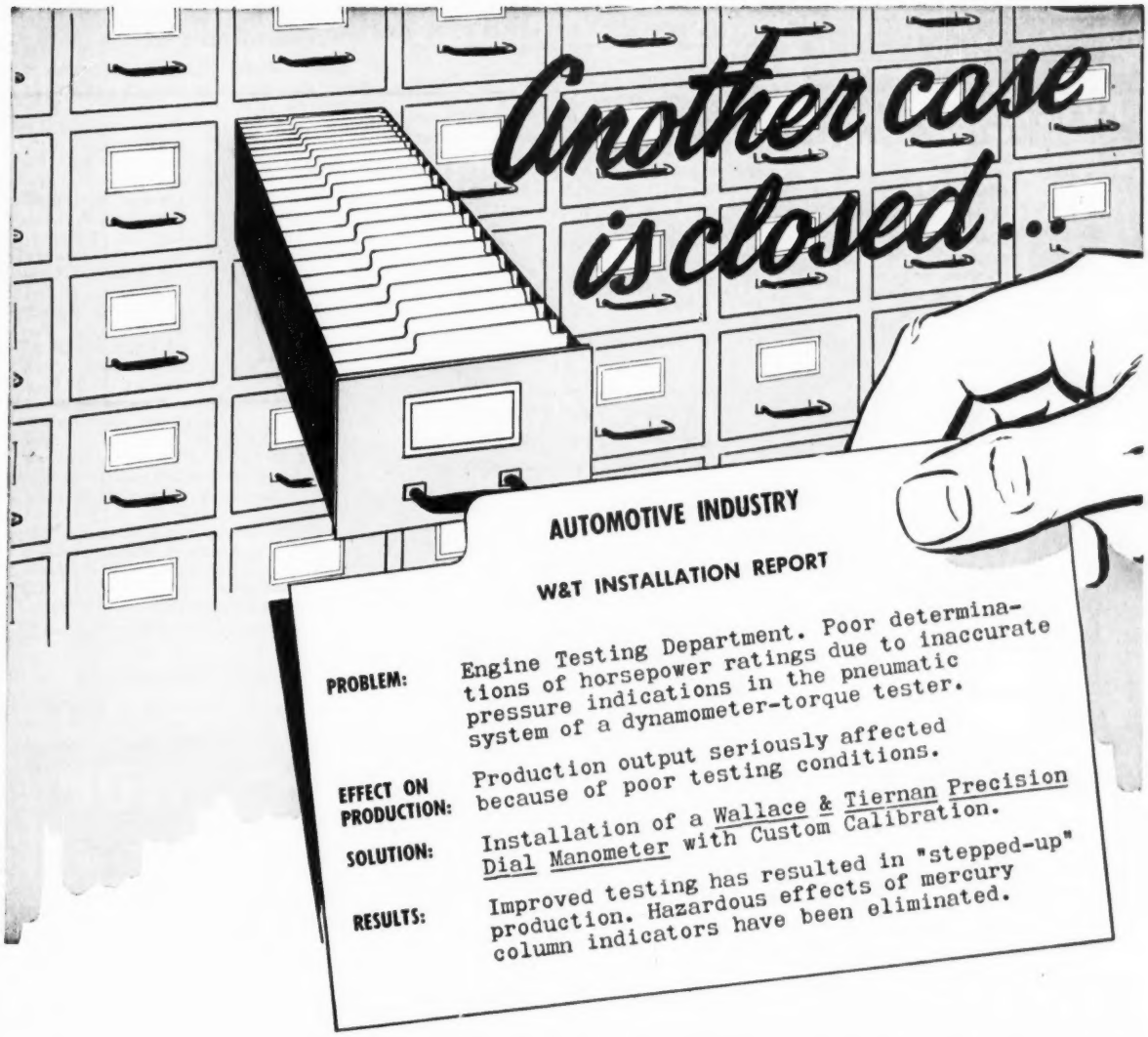
New line of four new "Raychronix" fast neutron proportional counters is said to meet a wide range of neutron flux measurements around reactors,

accelerators and neutron sources; will detect neutrons exclusively in fields of several roentgen of gamma radiation; can be used for remote monitoring.—*Radioactive Products, Inc., 443 W. Congress St., Detroit 26, Mich.*

For more information circle **270** on inquiry card.

Multi-purpose Radiation Instrumentation

New "Model 15 Basic Laboratory" is equipped with Veeder Root register and Standard Electric timer; accommodates anthracene, sodium iodide, and other crystals, including


another case is closed...
AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument

W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure

Custom calibrated scales in units of force or torque

Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.

Sensitivity one part in 10,000; accuracy one part in 1000.

If you have a problem in the measurement or control of pressure, write today for additional information.

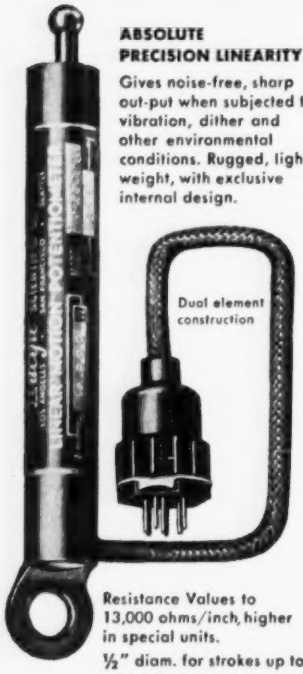
WALLACE & TIERNAN
PRODUCTS, INC.

ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS

Belleville 9, New Jersey • Represented in Principal Cities
In Canada, Wallace & Tiernan Products, Ltd. — Toronto

A-93

HUMPHREY LINEAR POTENTIOMETER



ABSOLUTE PRECISION LINEARITY

Gives noise-free, sharp out-put when subjected to vibration, dither and other environmental conditions. Rugged, lightweight, with exclusive internal design.

Resistance Values to 13,000 ohms/inch, higher in special units.

½" diam. for strokes up to 3"

¾" diam. for strokes over 3"

SPECIAL CONSTRUCTION AVAILABLE FOR HIGH TEMPERATURE APPLICATIONS

NEW HUMPHREY ACCELEROMETER

Readily adapted to wide selection of g ranges.

Accuracy: From plus or minus 1% at zero, to plus or minus 2% at maximum acceleration.

A RUGGED, COMPACT ACCELEROMETER with integral Potentiometer take-off, giving amazing accuracy under adverse conditions, due to the rugged construction. No "cross-talk".

FULLY TESTED AND QUALIFIED FOR MILITARY APPLICATIONS

Pacific SCIENTIFIC CO.

1430 Grande Vista Ave., Los Angeles 23, Calif.
25 Stillman Street, San Francisco 7, Calif.
1915 1st Avenue South, Seattle 4, Washington
806 East Abram Street, Arlington, Texas

Eastern Representative: Aero Engineering Inc. Mineola L.I., N.Y.; Indianapolis; Baltimore; Montreal

For more information circle **42** on inquiry card.

NEW INSTRUMENTS

thermal neutron crystals. Features include: direct-coupled amplifier with gain of 2500 which overloads without overshoots; stability factor greater than 100; unit may be used as an integral type pulse height analyzer; discriminator control is a ten turn Helipot; high voltage range is negative 500 to 1500; depressed zero scale; high-voltage regulation better than 0.005 for 1 percent change in line voltage.—*Radiation Instrument Development Lab., 2337 W. 67th St., Chicago 36, Ill.*

For more information circle **271** on inquiry card.

ELECTRICAL INSTRUMENTS

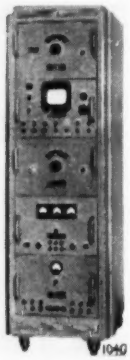
Wavemeter

New "Model WIN6AA 6-60-Cm. Wavemeter" features wide range which obviates need for several wavemeters; one setting only required; indication on easy-reading dial counter; reads wavelength directly in centimeters; indicates to two decimal places; auxiliary meter jack.—*Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland 3, Ohio*

For more information circle **272** on inquiry card.

Spectrum Analyzer

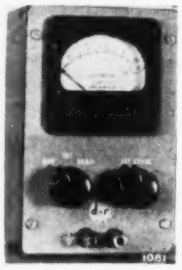
New "Model LSA" all-band spectrum analyzer has had its range further extended to 21,000 Mc.; it facilitates design problems in laboratory and provides a go-no-go tool for factory. It comprises a quintuple superheterodyne receiver working into a cathode-ray display. To obtain spectrum, tuning unit is set to desired frequency. Spectrum analysis is obtained by frequency-modulating second local oscillator. This obviates necessity of sweeping klystron modes and insures both linear frequency display and linear dispersion independent of frequency of signal to which analyzer is tuned. A mixer strip heterodynes the signal down to low frequency of final i-f. amplifier to assure good frequency stability. Passing resulting spectrum through narrow 25-kc. bandwidth final i-f. amplifier provides constant resolution for all signal frequencies. —*Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.*



For more information circle **273** on inquiry card.

Distortion Meter

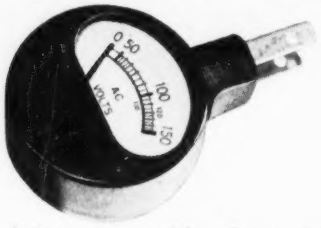
New "Model DM-1" distortion meter can be easily held in one hand; measures at a single frequency; differs radically from most d-m. equipment in that filter suppresses a band of frequencies, making it unnecessary to balance for a null. Readings are independent of flutter produced by recording medium. Although first designed for checking distortion and noise level on tape recorders (it meets all requirements of NARTB tape noise level measurement) it is being suggested to replace expensive laboratory equipment, wherever a single frequency measurement is adequate. It is suited for production and maintenance requirements in stations, studios, audio equipment plants and for hi-fi technicians and fans.—*D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.*



For more information circle **274** on inquiry card.

Plug-in Voltmeter

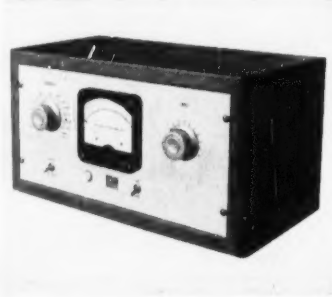
New plug-in voltmeter is available to service men for own use or resale to customers. Prongs have a swivel arrangement permitting dial to be read from any position. Instrument has a damped movement; range 0-150 volts; guaranteed accuracy 5 percent. —*Electro Mechanical Instrument Co., 813 Chestnut St., Perkasie, Penna.*



For more information circle **275** on inquiry card.

Micro-microammeters

New "Vibrating Reed and Logarithmic Scale Micro-Microammeters," said to be "two major advancements in microcurrent instrumentation for industrial control," can be employed to measure, record and control microcurrents on the order of one millionth of a millionth of an ampere. (1) Plug-in "Vibrode" glass-envelope vibrating-reed modulator is basic unit



NOW...fast, accurate transmission of DIFFERENTIAL PRESSURE MEASUREMENT with the Ashcroft Pneumatic Transmitter

Thousands of Ashcroft Pneumatic Transmitters are accurately measuring *straight pressures* in processing plants everywhere. Now, coupled with an exceptionally rugged differential pressure cell, the Ashcroft Transmitter assures the same standard calibrated accuracy of ½ of 1% in measuring *differential pressures.*

The Ashcroft Pneumatic Transmitter with Differential Pressure Cell is ideal for oil refineries, chemical plants or wherever it is good safety engineering to confine inflammable, poisonous or corrosive liquids or gases close to their source—away from control centers.

This new combination provides a durable and dependable system suitable for static pressures up to 4500 psi. It operates on low-pressure air—transmits proportionate air pressure to one or more pressure-actuated receiving indicators, recorders and controllers up to 1000 feet away. Response is fast—only 3 to 10 seconds for full scale change.

Installation is easy and economical. Low-cost, small-diameter piping is used. You avoid expensive high-pressure lines and fittings and all their leakage and maintenance problems.

Learn all about the basic types and differential pressure ranges in which the Ashcroft Pneumatic Transmitter with Differential Pressure Cell can be supplied. Write for Bulletin 330.

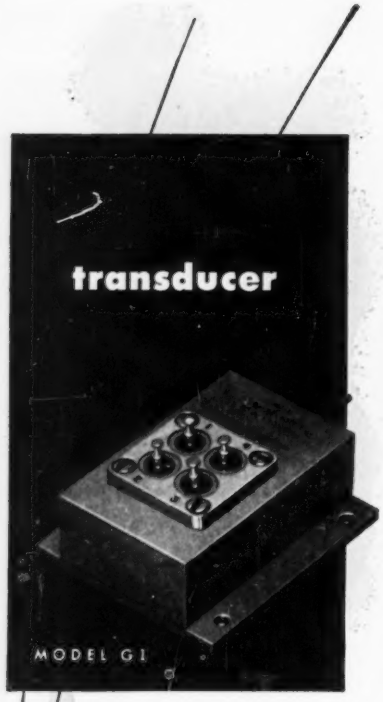
YOUR INSTRUMENT DISTRIBUTOR makes it his business to keep up with all that's new in process equipment. Call on him for practical counsel, efficient service and products you can depend on to save time, effort and money.

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **43** on inquiry card.



The Model G1 transducer is a research tool designed for the measurement of forces from ± 1.5 ounces to ± 80 ounces and for the measurements of displacements to ± 0.0015 inch.

Since the moving parts of the transducer weigh but 4.3 grams, the dynamic characteristics of most systems to which it is coupled are relatively unchanged.

Force or displacement applied to the transducer probe is translated into an exact electrical equivalent by means of a complete balanced bridge of strain sensitive resistance wire.

Please request Bulletin No. 1.1.

Statham LABORATORIES
• Los Angeles 64, Calif.

For more information circle **44** on inquiry card.

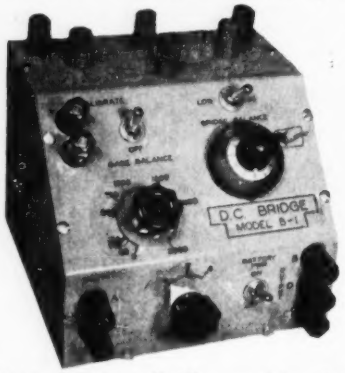
NEW INSTRUMENTS

of illustrated "Model V Micro-Microammeter." It can be replaced as easily and inexpensively as a vacuum tube. Instrument has 13 operating current ranges from 3×10^{-7} to 3×10^{-13} amp. full scale; absolute accuracy 5 percent or better on any scale; readings independent of line-voltage fluctuations from 103 to 107 volts and relatively insensitive to vibrations. Instrument can be adapted to monitor four inputs sequentially and has terminals for connection to any standard 50-mv. potentiometric recorder. (2) For use where input currents are likely to fluctuate, "Logarithmic Scale Micro-Microammeter" has been designed with a wide current range on a single scale covering six decades (10^{-7} to 10^{-13} amp.) with each decade graduated in nine subdivisions. It features high resolution, self-calibration and rapid response to signals; is suitable for applications wherever fluctuating microcurrents are measured or controlled.—*Beckman Instruments, Inc., South Pasadena, Calif.*

For more information circle **276** on inquiry card.

D-c. Bridge

New "Model B-1 D.C. Bridge" was designed as a general-purpose unit for wire strain gages and pickups or transducers. Balance is effected by a

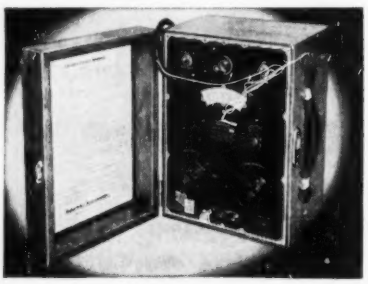


10-turn voltage-dividing resistor for all gage resistances in range of 60-2000 ohms. Input is for 1-, 2-, and 4-arm gages and pickups.—*Allegany Instrument Co., 1000 Oldtown Rd., Cumberland, Md.*

For more information circle **277** on inquiry card.

Conductivity Bridge

New "Type RC-16B" general-purpose conductivity bridge for electrolytic conductivity and electrical test measurements is an improved version

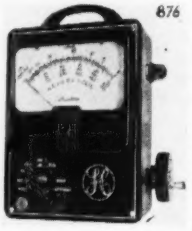


of "Type RC," features variable sensitivity control up to a maximum of 1/3 of 1 percent; range from 0.2 ohm to 2.5 megohms; accuracy within 1 percent of measured resistance. Two bridge source frequencies: a-c. line, and 1000 cps.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **278** on inquiry card.

Meg-ohm-voltmeter

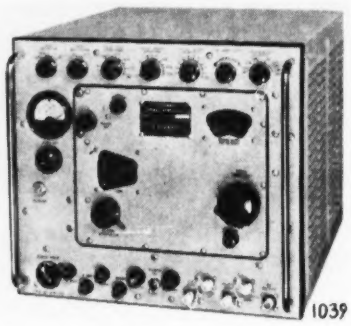
New "Model 640 Meg-ohm-voltmeter" provides a 500 v.dc. source for insulation testing by means of a hand crank generator (cranking in either direction); is capable of measuring up to 200 megohms. Also included are provisions for resistance testing from 0 to 2,000 ohms; three a-c. voltage ranges: 0-150, 0-300 and 0-600; and three d-c. voltage ranges: 0-150, 0-300 and 0-600.—*All Mail Sales Co., 100 Park Place, New York 7, N. Y.*



For more information circle **279** on inquiry card.

Microwave Signal Generator

New "Model MSG-4" microwave signal generator features single dial control, 1 percent accuracy, and sim-

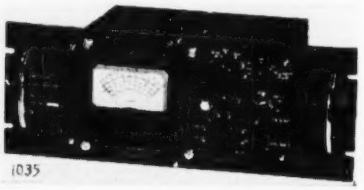


plicity of operation; covers frequency range 7,000-10,750 Mc. Other features include temperature compensation, long-life cavity design, wide range of modulation frequency as well as pulse, FM, internal and external.—*Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.*

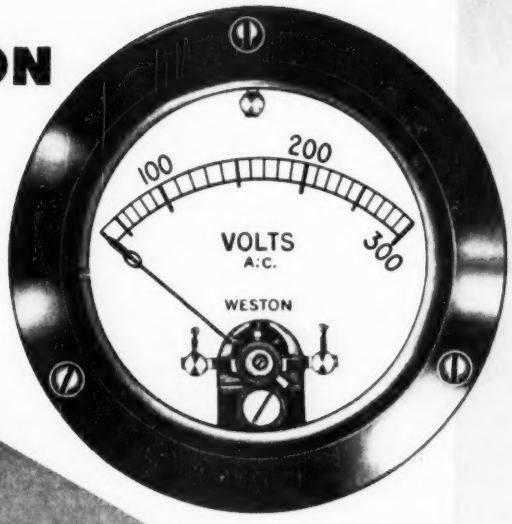
For more information circle **280** on inquiry card.

Rack-mounted VTVMs and Ammeters

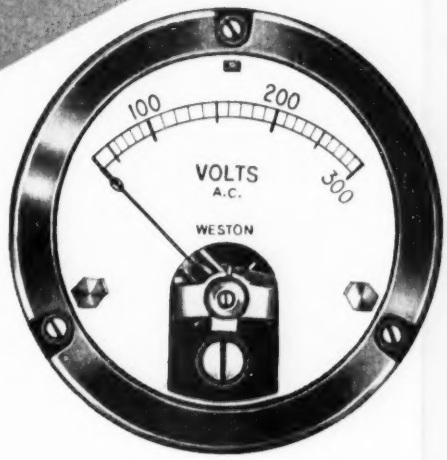
New rack-mounted vacuum tube voltmeters and ammeters correspond to the older portable type, can be equipped with or without terminals for connection of external indicating

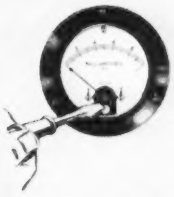


another WESTON FIRST



A-C ruggedized instruments





All Weston Ruggedized instruments have externally operated sealed zero correctors.

Insulated, breakproof connection terminals are molded into internal rubber.

Tough, flat plastic windows are really shock resistant.

WESTON Ruggedized Instruments are available not only in D-C but in movable iron A-C, rectifier type A-C and thermo. *All* are supplied with essential sealed *zero correctors*—shock-resisting flat plastic windows—and connection terminals molded into internal rubber, *leakproof, breakproof and effectively insulated.* For complete details, write for bulletin. Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON ruggedized instruments

For more information circle **45** on inquiry card.

"SERV-RITE"

Insulated Thermocouple Wire Extension Lead Wire

FOR

PLATINUM COUPLES
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
Asbestos Braid
Weatherproof Braid
Glass Braid
Polyvinyl Plastic
Nylon Braid
Stainless Steel Armored Braid
Silicone Treated
Cotton Braid
Lead Jacket

The home of "SERV-RITE"

Full Particulars on Request

4229

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines

Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

For more information circle 46 on inquiry card.

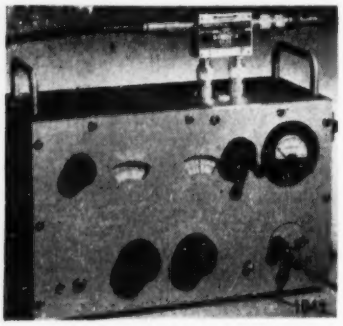
NEW INSTRUMENTS

instruments and recorders. Most important of new models are "RM-17B" d-c. millivoltmeter (illustrated), lowest range 0-1 mv., 6 megohms input; "RM-18B" r-f. meter, lowest range 0-10 mv., 1 Mc. to 2,500 Mc.; and "RM-12A" a-c. voltmeter, lowest range 0-3 mv., 20 cps. to 250 kc. In addition, ammeters and multi-meters are available in rack-mounted form. —*Millirac Instrument Corp., 444 Second St., Schenectady 6, N. Y.*

For more information circle **281** on inquiry card.

Reflection Coefficient and Load-matching Instrument

New "Model 136A Reflection Coefficient Meter," for rapid measurement of reflection coefficient of vswr, provides a convenient method of matching loads to lines to minimize

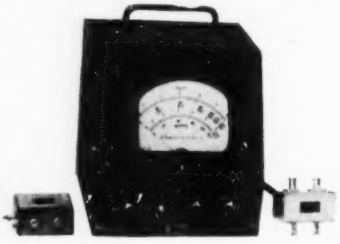


reflected power; may be used also as a wide-range lab receiver for general measurement purposes. It includes a local oscillator continuously tunable from 92 to 355 Mc. and an i-f. amplifier centered at 60 ± 2 Mc.; and a detachable directional coupler for insertion into transmission line under test.—*Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.*

For more information circle **282** on inquiry card.

Phasemeter Voltmeter

New "Type 213 H-F Phase & Vector Voltage Meter" is based on a new differential rectifier circuit developed by maker's staff; is said to be capable

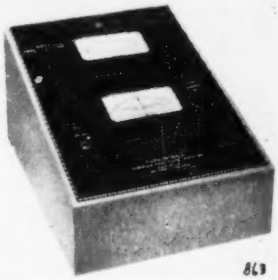


of performing a "tremendous number of tasks" in measurement of antenna systems, filters, amplifiers, and other h-f. transmission networks. Frequency range is 10 kc. to 300 Mc. with jack-input probe and 100 kc. to 1000 Mc. with coaxial probe (both probes supplied); lower limit may be extended to 1 kc. with two additional coupling capacitors; upper limit may be extended with relaxing accuracy. Input impedance is 2.5 uuf shunted with 100,000 ohms with jack-input probe. Coaxial-input probe is normally designed for 50 ohms characteristic impedance. Voltage range 0.6, 6, and 60 volts full-scale; can be made 0.3 volt full-scale through a simple adjustment. Phase angle range 0-180 and 180-360 deg. full-scale. Ranges with better angular sensitivity may be arranged. Accuracy 5 percent nominal—*Advance Electronics Co., P.O. Box 394, Passaic, N. J.*

For more information circle **283** on inquiry card.

Kilovoltmeter

New "Kilovoltmeter & Variation Percentage Indicator" measures voltages from zero to 60 kv. in three ranges, 0-1200 volts, 0-30 kv., 0-60

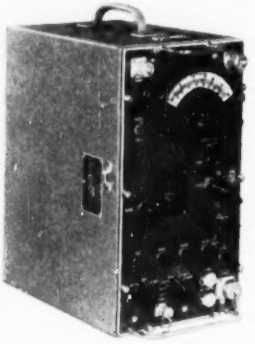


kv., and simultaneously observe on a second meter the voltage variations directly in percentage down to 0.05 percent. Sensitivity is 20,000 ohms per volt for 0-1200 volt range; 25 and 50 microamperes full scale for 30 kv. and 60 kv. ranges respectively. Accuracy: Kilovolt ranges and percentage readings: 3 percent, 0-1200 volt range: 2 percent.—*Neutronic Associates, 83-56 Victor Ave., Elmhurst 73, N. Y.*

For more information circle **284** on inquiry card.

BF Oscillator Kit

New "NM-20 Series" radio interference and field intensity meter has addition of a beat frequency oscillator, enabling user to identify and



copy unmodulated c-w. signals throughout frequency range 150 kc. to 25 Mc. Owners of "NM-20A" can add this circuit improvement to their equipment by procuring "#90828-1 Beat Frequency Oscillator Kit," which comes complete with all parts, wire, and hardware, installation instructions, and requisite drill templates

TEAMED TO EXPLOIT ACCURACY

Selective Amplifier With Over 65 db Gain
VISUAL BALANCING
High and Low Voltage Current Limited D.C.
20 db Rejection at 2nd Harmonic
Both Oscillator and D.C. Generator for Bridge Operation
Any Fixed Frequency from 100 CPS to 10 KC

BECO DEKADIAL
36 feet of scale length with 38,000 discreet increments
ACCURACY — Resistance: ±0.1%; Capacitance: ±0.25%; Inductance: ±1.0%.

BECO
MODEL 855-AI
OSCILLATOR AMPLIFIER

- Specifically designed to afford full utilization of outstanding accuracy and range of Beco Model 250-CI Impedance Bridge.
- Complete operation of the 250-CI Bridge from A.C. power.
- Highly stable oscillator, accurate to within 1% of nominal frequency.
- Maximum convenience. Visual null indication. No batteries.

BECO
MODEL 250-CI
IMPEDANCE BRIDGE

- Features Beco Dekadial for accurate resistance, capacitance, inductance. Readings to four significant figures.
- The most accurate, widest range Impedance Bridge available.
- Compact, light, portable. 9" x 11" x 11" over all.
- Wide range:
  Resistance — 1 milliohm to 11 megohms.
  Capacitance — 1 $\mu\mu$f to 1100 μfs.
  Impedance — 1 μh to 1100 henrys.

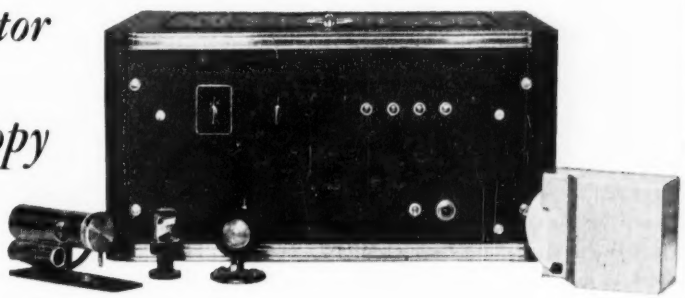
◆ Model 855-A1 Oscillator-Amplifier $170
◆ Model 250-C1 Impedance Bridge $340
◆◆ Team $510

Write for Literature and Name of Local Sales Representative

BROWN ELECTRO-MEASUREMENT CORP. / 4312 S. E. Stark St. Portland 15, Oregon

For more information circle **47** on inquiry card.

A Superior Detector for Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. An effective sensitive area 3/32" in diameter.
2. Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.
3. Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.
4. Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

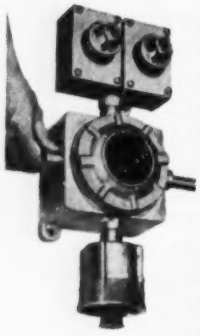
For more information circle **48** on inquiry card.

DETECT combustible GAS

INDICATE • RECORD • CONTROL

MODEL F

J-W Model F Indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

SENTINEL

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

Write for complete information

JOHNSON-WILLIAMS, Ltd.

PALO ALTO 3, CALIFORNIA

For more information circle **49** on inquiry card.

NEW INSTRUMENTS

for locating and adding holes.—*Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.*

For more information circle **285** on inquiry card.

Six-channel Oscillograph

New "Type 5-117" is announced as a low-cost oscillograph, recording up to six active data channels in 0-300-cps. range with positive time correla-

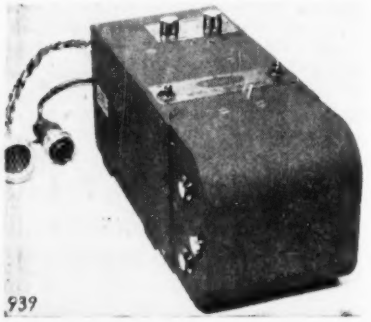
1079

tion. It permits making many tests without use of amplifiers, for available galvanometers may be driven directly by small electrical signals (undamped d-c. sensitivity 7.9ua./in. available). Six record speeds from ¾ to 24 in./sec. Timing lines recorded every 0.01 sec. along one edge of record, with every tenth line emphasized. A 5-digit counter (visible from control panel) is advanced at beginning of each record and photographed to provide positive record identification. Light-tight magazine, removable as a unit, is equipped with interlocking latch and shutter to prevent fogging. Unexposed-footage indicator for 70-mm.-wide by 100-ft. long photographic paper.—*Consolidated Engineering Corp., Pasadena 15, Calif.*

For more information circle **286** on inquiry card.

14-channel Oscillograph

New "Model 557" oscillograph possesses all the operational features of maker's "Model 555," while possessing most of ruggedness and shock resistance of "Model 560." It accommodates the same record magazine as "Model 560." Other features: (1) 14 channels of separate data; (2) rigid cast aluminum alloy construction; (3) full-width timing lines at 0.01 and 0.1 seconds produced by a shutter-type *G*-proof precision timer; (4) trace identification (beam-interrupter type); (5) record speed varied by simple gear-shift arrange-



939

ment; (6) full-width viewing screen displays traces having a one-to-one deflection ratio with recording traces. This oscillograph will accommodate any of natural frequencies and sensitivities available in "Models 102, 106 and 108."—*Midwestern Geophysical Lab., 3401 S. Harvard, Tulsa, Okla.*

For more information circle **287** on inquiry card.

Frequency Meters

New frequency meters for laboratory and field use are supplied complete with microammeter, sensitivity control and calibration charts. Cavity

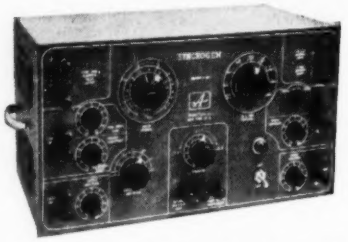
912

is an end-loaded coaxial resonator operating as a radial line. A coaxial variable capacitor built into cavity is adjusted by a micrometer drive. Accuracy is better than 0.05 percent from 20 to 120 F. Sensitivity provides usable indication with 1-milliwatt input. Four models available, with ranges of 900-1200, 1200-1600, 1600-2250 and 1700-2550 Mc.—*Frequency Standards, P. O. Box 504, Asbury Park, N. J.*

For more information circle **288** on inquiry card.

Multi-waveform and Pulse Generator

New "Model E-10 Syncrogen," multi-waveform generator and pulse synchronization unit, supplies: sawtooth waves; square waves or square top

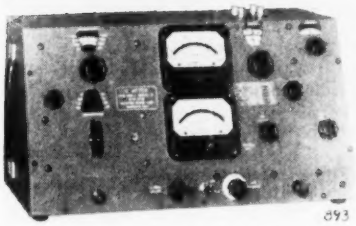


pulses 1 usec. to 1 sec. duration with rise time of 0.15 usec.; integrated or differentiated versions of square waves or pulses. All outputs are simultaneously available, independently variable in amplitude, may be synchronized, triggered or gated by sine waves, pulses or other complex wave forms. Frequency range 1 cps. to 100 kc.—*Amplitronix, Inc., 280 Ninth Ave., New York 1, N. Y.*

For more information circle **289** on inquiry card.

Q-meter

New "Type 260-A Q Meter" is completely redesigned, replaces the "Type 160-A", has a frequency coverage of 50 kc. to 50 Mc. Among new features:

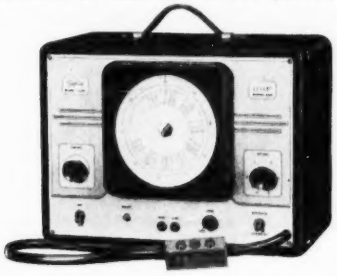


a low-Q scale permits Q readings down to 10; a delta Q scale gives difference in Q resulting from changes in test circuit parameters and covers range from 0 to 125; indicating instruments have parallax correction and an accuracy of 1 percent of full scale; a new oscillator range switch actuates a mask which exposes operating frequency dial range; redesigned voltage injection system incorporates a specially-developed 0.02-ohm annular resistor which exhibits constant resistance and negligible reactance over entire frequency range.—*Boonton Radio Corp., Boonton, N. J.*

For more information circle **290** on inquiry card.

UHF Marker-generator

New "Model 3436 UHF Marker Generator and Signal Generator" has following features: UHF all fundamentals on channels 14-83 (470-900

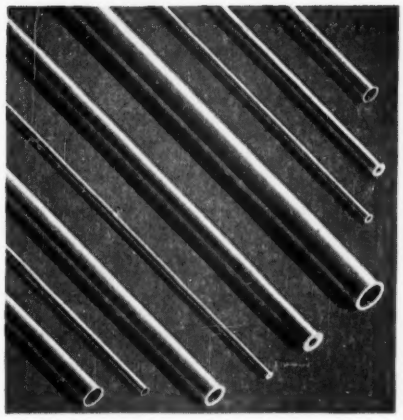


Mc.); no harmonics for confusion; large dial (13-in. scale) with uniform frequency graduations—no crowding at end of dial; marked in both frequency and channels, hand-drawn for extreme accuracy; r-f. output average 0.3 volt; variations in output minimized; output impedance 150 and 300 ohms; piston-type attenuator; triple shielding; voltage-regulated power supply; adjustable modulation of r-f. signal at approx. 1000 cycles; 0-20-volt audio output at panel. Can be used as horizontal bar generator.—*—The Triplett Electrical Instrument Co., Bluffton, Ohio.*

For more information circle **291** on inquiry card.

Program Equalizer

New "Type 4201" program equalizer, utilizing only 3.5 in. of rack space, features low hum pickup, ability to return to positions of known operating conditions. Transmission deficiencies, when known, may be pre-set. Low-frequency equalization is peaked at 40 and 100 cps. in 2-db steps up to 12 db; high frequency equalization is peaked at 3, 5 and 10 kc. in 2-db steps up to 12 db; selections by switch. Low-frequency attenuation is in 2-db steps at 100 cps.; maximum attenuation 16 db; high-frequency attenuation in 2-db steps at 10 kc.; maximum attenuation 16



Yes, it's tubing—Uniform "Pointer" tubing used as the indicator in this Simpson Electric Company Model #1029 Milliammeter. Uniform pioneered the development of delicate, aluminum alloy "Pointer" tubing; today furnishes over 50% of all such tubing used in the United States.

Photo courtesy of Simpson Electric Company, Chicago, Illinois.

Whenever you need

SMALL TUBING

CONTACT **UNIFORM TUBES**

Copper, Brass, Aluminum-.010" to 5/8" O.D.

Fine, seamless tubing from .010" to 5/8" O.D.—any wall thickness. Precision-tolerance "Pointer" tubing from .010" to .048" O.D.; walls to .0010"—choice of six aluminum alloys. Miniature tubing components for transistors and other electronic equipment. While the bulk of our production is brass, copper, and aluminum, we also draw nickel, steel, silver and other analyses.

Whatever your small tubing needs, it will pay you to check with Uniform. Our new Collegeville plant gives us three times previous production capacity, and in spite of defense demands, we can still quote 3-4 weeks delivery on most orders. You'll particularly like our attractive quotations—furnished on request.

UNIFORM TUBES, INC.

1201 Level Road, Collegeville 2, Pennsylvania

AGENTS IN PRINCIPAL CITIES

SEND FOR FREE CATALOG!

Uniform Tubes, Inc.
1201 Level Road
Collegeville 2, Pa.

Please send me without obligation a copy of your General Catalog.

Name _____ Title _____

Company _____

Street & No. _____

City _____ Zone _____ State _____

For more information circle **50** on inquiry card.

PALMER

MERCURY ACTUATED

Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

PALMER

THERMOMETERS, INC.

Cincinnati 12, Ohio • MElrose 1500

For more information circle **51** on inquiry card.

NEW INSTRUMENTS

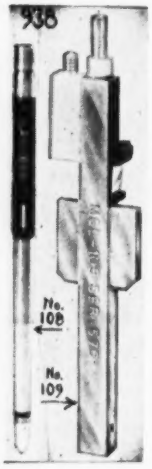
db. Circuit: bridged T constant impedance; impedance: 500/600 ohms, in-out; insertion loss: 14 db constant. —*Hycor Co., Inc.*, 11423 *Vanowen St., North Hollywood, Calif.*

For more information circle **292** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Oscillograph Galvanometers

New "Model 108" galvanometer has extraordinary resistance to shock effects. (An ordinary galvanometer goes completely wild when subjected to even a small shock and, as a result, trace is useless until effects of shock have died away.) New galvanometer makes possible oscillograph recording during shock and vibration conditions, without sacrifice in ordinary galvanometer performance characteristics, such as sensitivity or frequency response. Galvanometer trace deflection due to shock is about one-fifth as great, and duration of shock-caused trace disturbance is about one-tenth as long, as exhibited by the most shock-resistant galvanometers previously available. "Model 108" galvanometer makes possible oscillographic recording through shocks as great as 100 *G*.



★New "Model 109" galvanometer, specifically designed to be utilized in Consolidated Engineering Corp. oscillographs, may also be used in maker's "Model 154" magnetic structure which is compatible with CEC galvanometers.—*Midwestern Geophysical Lab.*, 3401 *S. Harvard, Tulsa, Okla.*

For more information circle **293** on inquiry card.

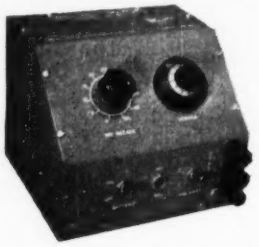
D-c. Amplifier

New "Model 55A Subminiature-Stabilized D. C. Amplifier," for telemetering or recording outputs of thermocouples and d-c. excited strain gages, has frequency response 2 percent from d. c. to 10 kc.; gain 1000; noise less than 25 microvolts rms. equivalent input signal at normal ambient temperatures. At 85 C. ambient and 10*G* vibration along equipment major axis in vicinity of 300 cps., maximum noise 100 microvolts equivalent input. Drift is an output zero offset which does not exceed 25 microvolts equivalent input signal. Nominal input range 0 to 5 millivolts; output impedance less than 50 ohms. Input and output are referred to ground. Complete amplifier, including stabilizing components, weighs 10 oz. Including nine-pin octal plug, over-all length is 5.12 in.—*Electro-Mechanical Research, Inc., Ridgefield, Conn.*

For more information circle **294** on inquiry card.

Millivolt Source

New "Model MV-60" self-contained millivolt source for calibrating indicating and recording instruments has low internal resistance resulting in

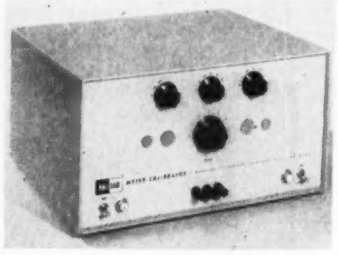


minimal loading errors. Range is 0-60 mv.; resolution is 10 microvolts.—*Allegany Instrument Co.*, 1000 *Oldtown Rd., Cumberland, Md.*

For more information circle **295** on inquiry card.

Calibration Sources

New models added to "Meter Calibrator" line afford precise d-c. voltage and current reference from 0 to 1000 volts and from 0.05 microamps to 100 milliamps. These units employ

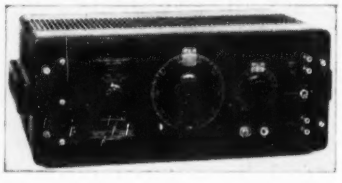


maker's "Absolute DC Power Supply System." All currents and voltages are referenced against an internal standard cell maintaining output constant regardless of line or load variations. New models feature 0.01 percent stability, calibration, and regulation.—*Kalbfell Labs., P. O. Box* 1578, *San Diego* 10, *Calif.*

For more information circle **296** on inquiry card.

Precision Phase Shifter

New "Type 704-A Secondary Phase Standard" is a precision phase shifting instrument for altering phase of an input sinoid by any amount between 0 and 360 deg. without disturbing either amplitude or waveform of



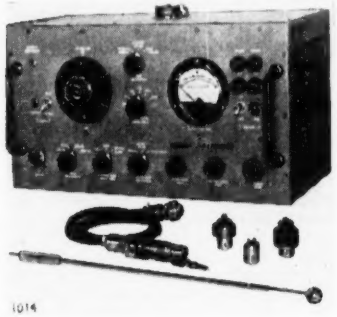
signal; has negligible loading effect on circuit into which it is inserted. Incremental phase shifts as small as 0.1 deg.; absolute accuracy within 1 deg. over entire 0-360-deg. range, provided signal frequency is held within 0.2 of rated frequency. Instruments are available for one of the

standard frequencies of 60, 400, 1000, or 20,000 cps.; and can be furnished for any other frequency between 60 cps. and 20 kc. on special orders.—*Technology Instrument Corp., Action, Mass.*

For more information circle **297** on inquiry card.

Noise Meter Converter

New "Model 104" converts any AM or FM radio receiver into an easily-calibrated noise meter and field intensity meter; may be used with any



1014

single receiver or combination of receivers covering 15 kc. to 1000 Mc. range. It has its own power supply, accurate attenuator (up to 50 db ± ½ db good up to 1000 Mc.), and output meter; is capable of reading slide-back (peak), quasi-peak and average. Various time constants, set up by ASA standards, are switchable for quasi-peak, and average positions. Unit has a double channel input, one channel devoted to standard (1-meter) rod antenna input which can be used for field comparison or antenna sensitivity evaluation. Provisions are also made for measuring either radiated or conductive noise.—*Dynamic Electronics-New York, Inc., P. O. Box* 188, *Forest Hills, L. I., N. Y.*

For more information circle **298** on inquiry card.

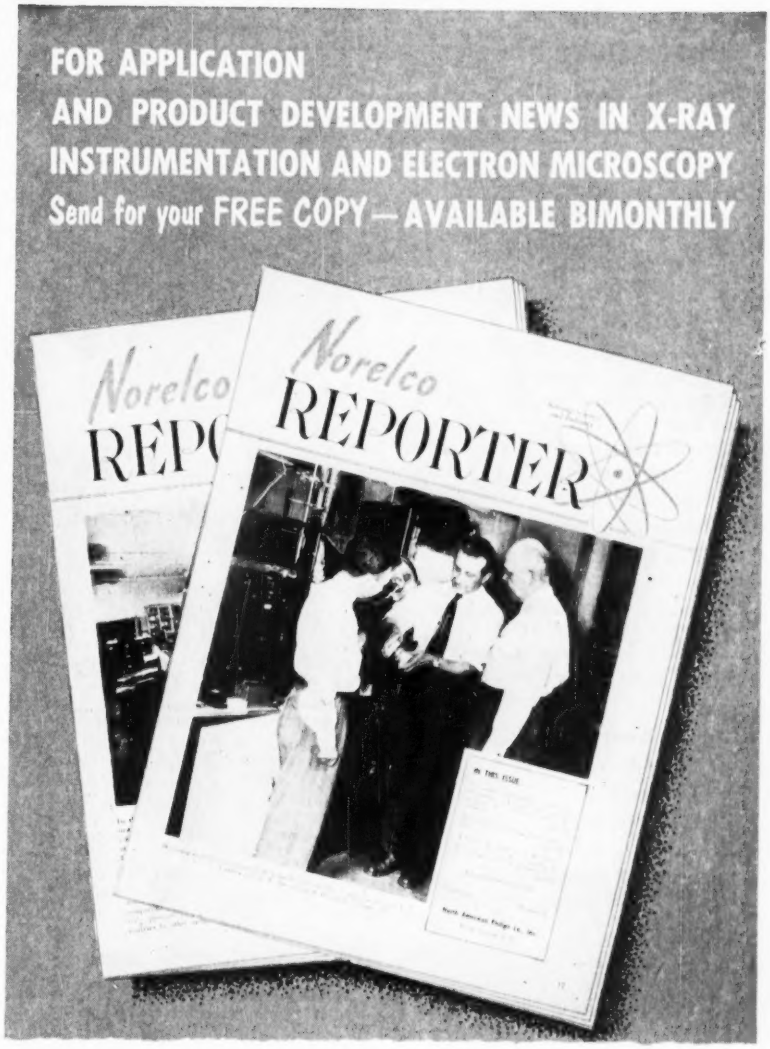
Frequency Multipliers

New "Power Frequency Multipliers" change frequency of line power without use of rectifiers; are hermetically sealed; operate directly from a 400-cps. 3-phase power line, delivering 2000-cps. single-phase output at a conversion efficiency of approximately 75 percent. "Model F-10" delivers 5 watts at 2000 cps. with good regulation and with a harmonic content less than 7 percent; "Model F-12" delivers 25 watts at 2000 cps.; "Model F-11" delivers 250 watts with low harmonic content and an operating efficiency in excess of 80 percent.—*D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.*

For more information circle **299** on inquiry card.

Frequency Changer

New "Model 2261 Frequency Changer" is said to be "ideally suited as a source for supplying bus power in a laboratory or power for production-line equipment." Output voltage frequency is 400 cps. plus or minus 1 percent regardless of transients in input voltage or load fluctuations. Output volt-ampere rating is 1500/-2500 at 115 volts single-phase. Input



A Norelco PRODUCT NORTH AMERICAN PHILIPS COMPANY, INC.

Serving Science and Industry

Dept. IM-12, 750 S. Fulton Ave., Mount Vernon, N.Y.

In Canada: Rogers Majestic Electronics Ltd., 11-19 Brentcliffe Road, Leaside, Toronto 17, Ontario

North American Philips Company, Inc.
Research & Control Instruments Division
750 South Fulton Avenue, Mount Vernon, N. Y.

Gentlemen:

Please place my name on mailing list to receive "Norelco Reporter" bimonthly without obligation.

Name .....

Title .....

Company .....

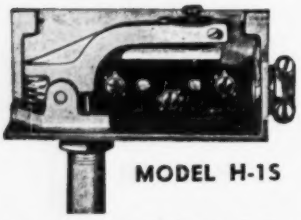
Address .....

City ..... **State** .....

IM-12

For more information circle **52** on inquiry card.

Temperature Limit Controls



MODEL H-1S

The Burling Model H-1S is approved by Factory Mutual Laboratories as a high temperature safety alarm or cut-out. It is used on ovens, furnaces, dryers, and similar equipment. Snap-action switch may be manual reset type.

Features of Other Burling Controls

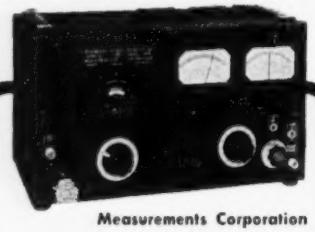
- Ranges from −300°F. to +1800°F.
- Electric or Pneumatic
- One, two or three Micro Switches
- Differential Expansion of Solids No liquids—no gases
- Explosion and waterproof housings

Send For Bulletin 101

Burling Instrument Co.
9 Vose Ave.
South Orange, N. J.

Burling TEMPERATURE Controls

For more information circle **53** on inquiry card.



Measurements Corporation
MODEL 80

STANDARD SIGNAL GENERATOR

2 Mc. to 400 Mc.

Individually Calibrated Direct-Reading Dial

FREQUENCY ACCURACY: ±0.5%

OUTPUT VOLTAGE: 0.1 to 100,000 microvolts.

OUTPUT IMPEDANCE: 50 ohms.

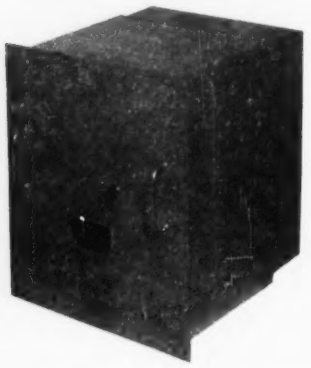
MODULATION: Amplitude modulation 0 to 30%. Internal modulation 400 and 1000 cycles. Provision for external pulse and amplitude modulation.

POWER SUPPLY: 117 volts, 50/60 cycles. 70 watts.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

For more information circle **54** on inquiry card.

NEW INSTRUMENTS



is 220-v. 60-cps. 3-phase, 12 amps. per phase. (External transformers available for other input ratings.)—*Varo Mfg. Co.*, 1801 *Walnut St., Portland, Ore.*

For more information circle **300** on inquiry card.

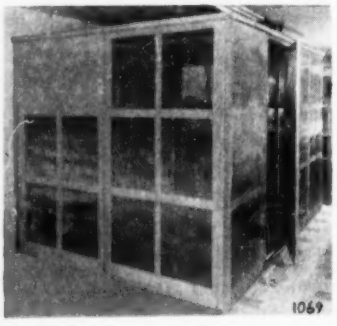
Screen Room

New screen enclosure is the first with fully interchangeable panels. It uses only two panel sizes, one panel for any wall position, the other fits any ceiling or floor position. Enclosure meets new MIL-S-4957 specification, is also available to industry. Attenuation is beyond that required by the specification: 114 db average from 200 kc to 413 Mc.—*Ace Engineering & Machine Co.*, 3644 *Lawrence St., Philadelphia* 40, *Penna.*

For more information circle **301** on inquiry card.

Shielded Room

New low-cost shielded room is a copper-screened enclosure of cell-type construction suitable for use in (a)



laboratories where some setups must be free from radio interference; (b) industrial plants, to enclose sources of excessive interference; (c) medical offices and laboratories. New shielded room is said to be characterized by logical simplicity of design and construction which makes for low cost with a high degree of shielding efficiency. Among features: no soldered joints, extreme simplicity in assembling and disassembling room, and near-complete transparency to light and circulating air.—*Ark Engineering Co.*, 431 *W. Tabor Rd., Philadelphia* 20, *Pa.*

For more information circle **302** on inquiry card.

"Slice-away" Batteries

New 21-volt alkaline battery assemblies can be sliced, like a package of candy mints, into numerous combinations of cells to provide different

voltage requirements; are intended specifically for equipment designers and experimenters exploring application possibilities of transistors. Both assemblies (VS087 for current drains up to 2 ma. and VS088 up to 10 ma.) contain 15 1.4-volt crown-type alkaline dry cells.—*Tube Dep't, RCA Victor Div., Radio Corporation of America, Camden, N. J.*

For more information circle **303** on inquiry card.

POWER SUPPLIES

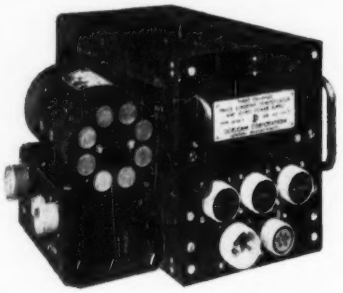
High-voltage Power Supplies

New high-voltage power supplies offer many features not found in maker's older models; come in ranges up to 25,000 volts; feature well-filtered d-c. output; choice of built-in direct-reading kilovoltmeters on any unit; also available with direct-reading microammeters for leakage measurements. Special cutout circuits protect indicators on accidental shorts. Units are said to be perfect for breakdown and leakage tests.—*Precise Measurements Co.*, 942 *Kings Highway, Brooklyn* 23, *N. Y.*

For more information circle **304** on inquiry card.

Power Supply & Demodulator

New "VFDD" flight test instrument, designed to serve as link between pickups and oscillograph, con-

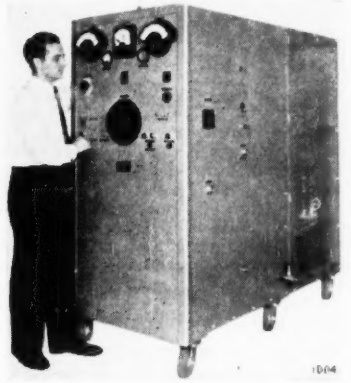


sists of: (1) power supply section suited for exciting gyros, acceleration and position pickups, synchros, etc.; (2) demodulation section comprising three demodulator channels to transform 400-cps. signals to d.c. for use with recording galvanometers.—*Doelcam Corp., Soldiers Field Road, Boston* 35, *Mass.*

For more information circle **305** on inquiry card.

High-voltage Power Supply

New "Model 2036" high-voltage d-c. power supply rated at 0-15,000 volts, 1 amp., for use with pulse-modulated magnetrons, etc., also



serves as a general-purpose high-voltage tester where large current are required. One man can move it on level floors (weight approx. 850 lbs.). Five indicating instruments: multiple-range load ammeter, output kilovoltmeter, a-c. line ammeter, filament voltmeter and operating time totalizer. Provisions are made for external automatic cycling circuits and for remote control. Output voltage is controlled manually by means of a continuously-variable autotransformer; motor control of this covat is optional. Automatic output shorting mechanism reduces output voltage to zero whenever primary power is removed. Access doors interlocks prevent high voltage from appearing internally if any door is open. Provision is made for external interlocks. —*Beta Electric Corp.*, 333 *East* 103*rd Street, New York* 29, *N. Y.*

For more information circle **306** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

Magnetic Amplifier

New "Model M-22" is said to be an exceptionally stable push-pull magnetic amplifier with a zero drift of less than 10^{-12} watt. Signals of 0 to 20 mv.dc. produce a linear output from 0 to 10 ma.dc. into a load of 100 ohms. Input impedance 5-25-50-100 ohms; extreme temperature range −50 to 70 C.; 2x2x2.5 in. for 60 cps. and 1.5x1.5x2 in. for 400 cps. —*Magnetic Controls, Inc.*, 119 *W. 63rd St., New York* 23, *N. Y.*

For more information circle **307** on inquiry card.

Ruggedized Triode

New "Type 6333" triode, an improved and ruggedized version of maker's standard "Type 892," is completely interchangeable with it but is superior in mechanical construction, performance and shock-resistance qualities. Among features: powdered glass stem, kovar grid ring, shorter over-all length, internal conical grid

Over 5,348 relay types . . . each subject to many electrical and mechanical adaptations . . . produced by a highly skilled organization which, for over 25 years, has specialized in relays exclusively.

Here is relay experience!

"RELAY ENGINEERING" the famous 640-page handbook brings you full benefit of Struthers-Dunn's experience in producing thousands of relay types for hundreds of applications. A complete, fully-illustrated guide to all phases of relay selection, use, circuitry and maintenance. Price $3.00.

STRUTHERS-DUNN

5,348 RELAY TYPES

Struthers-Dunn, Inc., 150 N. 13th St., Philadelphia 7, Pa.

BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES
MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

For more information circle **55** on inquiry card.

ADVANCED ELECTRONIC DESIGNS... by AVION

FREQUENCY CONVERTER—MODEL 400

A 400-CYCLE POWER SUPPLY BENCH SIZE

- Plugs into 60-cycle line
- Delivers 100 volt-amperes
- Output frequency and amplitude adjustable through entire AN-E-19 Range: 380-420 cps 105-130 volts

Frequency Regulation: Better than ±1 cps
Voltage Regulation: Better than ±1%
Harmonic Distortion: Total better than 3%
Independent of power factor

The small size (17" long x 11½" wide x 9" high), power output (100 V-A), and low cost afford the convenience of using one converter for each bench set-up. Four hundred cycle power handling capacity need be paid for only as required.

PRECISION VOLTAGE REGULATOR—MODEL 116
400-CYCLE

- Regulation: ±0.01% for 0 to 50 VA load variation ±0.02% for 0 to 100 VA load variation (When output set to center of ±10% input voltage variation)
- Developed harmonics: better than 1%
- Transient time constant: better than 0.01 seconds

Low harmonic distortion and low transient time constant result from the use of a push-pull feedback amplifier in the output. These features, together with the unusually high regulation, suggest the superiority of the Model 116 as compared with ordinary 400-cycle regulators.

Send for complete data on these Avion products

OTHER AVION PRODUCTS

Altitude & Air Speed Control Units • Electronic Choppers • Electronic Inverters
Magnetic Memory Systems • Miniature Plug-In Amplifier Units • Miniature Precision Potentiometers
Multron • Power Supplies • Replaceable Subminiature Amplifier Assemblies • Signal Generators

AVION
INSTRUMENT CORP.
Division of American Car and Foundry Company
299 Highway No. 17 • Paramus, New Jersey

EXPORT REPRESENTATIVE: Rocke International Corp., 13 E. 40th Street, New York 16, N. Y.
Cables: "ARLAB" New York • All Codes

CANADIAN REPRESENTATIVE: Aeromotive Engineering Products, 3257 Queen Mary Road, Montreal, Que.

For more information circle 56 on inquiry card.

support, kovar anode seal, spiral filament and lower inductance.—*Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L.I., N. Y.*

For more information circle **308** on inquiry card.

Ignitrons

New "Types AX-5551, AX-5552, AX-5553, AX-5554, and AX-5555 ignitrons are added to maker's line of industrial tubes. They are electrically and mechanically identical and interchangeable with standard types of same designation. Features include an improved long-life ignitor and a heavy detachable braided copper anode lead.—*Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L.I., N. Y.*

For more information circle **309** on inquiry card.

Low-microphonic Triode

New "Type CK 6247" subminiature low-microphonic triode features maximum noise output of 1 mv., a reduction of 8 db from original-announcement limit. Noise output is thus 26 db lower than that of any other known tube type except maker's "CK5703-WA" which has a maximum limit of 10 millivolts.—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **310** on inquiry card.

Gated-beam Discriminator

New "Type 6BN6" gated-beam discriminator type tube is a new type of electron tube which performs function of limiter, discriminator, and audio amplifier, thus reducing number of tubes needed in sound channel applications for FM and TV receivers, etc. It is said to have "many other interesting applications."—*Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.*

For more information circle **311** on inquiry card.

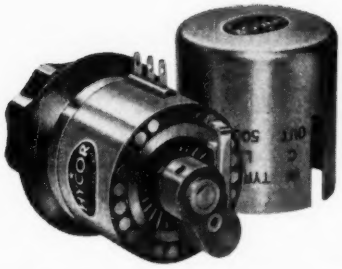
Noise-suppressor TV Tube

New "Type 6CS6" tube, for combined sync-separator noise-suppressor use, is designed to be used in circuits that accomplish sync separation by feeding video signal extending in a positive direction to grid 3 where negative grid leak bias development automatically adjusts clipping level. Noise suppression is obtained by applying a video signal extending in a negative direction to grid 1: strong noise impulses cause tube cutoff momentarily and thus reduce harmful effects of noise on picture tube sweep circuits. Grid 3 has a sharp cutoff characteristic to facilitate clipping action which removes picture information from sync pulses. New tube is in T-5½ bulb style and has a 6.3-volt heater.—*Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.*

For more information circle **312** on inquiry card.

Variable Attenuator

New variable attenuator has non-inductive wire-wound resistive elements hermetically sealed in a tough plastic compound, proofing against



shock, moisture and temperature. Stock types available with "ladder," "T," "H," "L" and VDR configurations up to 32 steps.—*Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif.*

For more information circle **313** on inquiry card.

Attenuator Pads

New "Micropads" represent a miniaturized type of microwave attenuator pad said to be extremely compact and rugged with no fine wires or delicate elements. Ability to withstand overloads of more than 100 percent is also claimed. Maker's platinum film microwave resistors are employed. — *Telewave Laboratories, Inc., 100 Metropolitan Ave., Brooklyn 11, N. Y.*

For more information circle **314** on inquiry card.

TV Interference Filter

New interference filter of three-section high-pass type, for use between transmission line and a TV receiver, will cut-off frequencies below 50 Mc., suppressing diathermy, amateur and industrial heating interference.—*United Technical Labs., Morristown, N. J.*

For more information circle **315** on inquiry card.

Silicon Diodes

Four new cartridge-type silicon diodes, for mixer use in microwave systems utilizing RG 50/U waveguide, are physically interchangeable with maker's standard "1N23B" and "1N-21B" but are designed for optimum performance at 6750 Mc. in maker's "P-570" mixer.—*Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.*

For more information circle **316** on inquiry card.

Power Resistor

New "Castohm," said to be a radically new type of fixed wire-wound power resistor, has windings firmly imbedded in a special ceramic which forms an integral coating and core. Thus, without usual heavy ceramic core, new resistors come in smaller diameters, with almost 25 percent less weight than conventional tab terminal power resistors of comparable wattage ratings, and rated at a hot-spot temperature of 350 C. compared with 275 C. for vitreous enamel types. Designed in accordance with Signal Corps specification MIL-R-10566, new resistors are currently available in ratings of 8, 28, 125, and 225 watts; resistance values from 100 to 160,000 ohms; Standard tolerance 5 percent but tolerance as

Quick Deliveries FROM STOCK

SHALLCROSS

DECADE *Resistance* BOXES

36 STANDARD TYPES FROM WHICH TO CHOOSE!

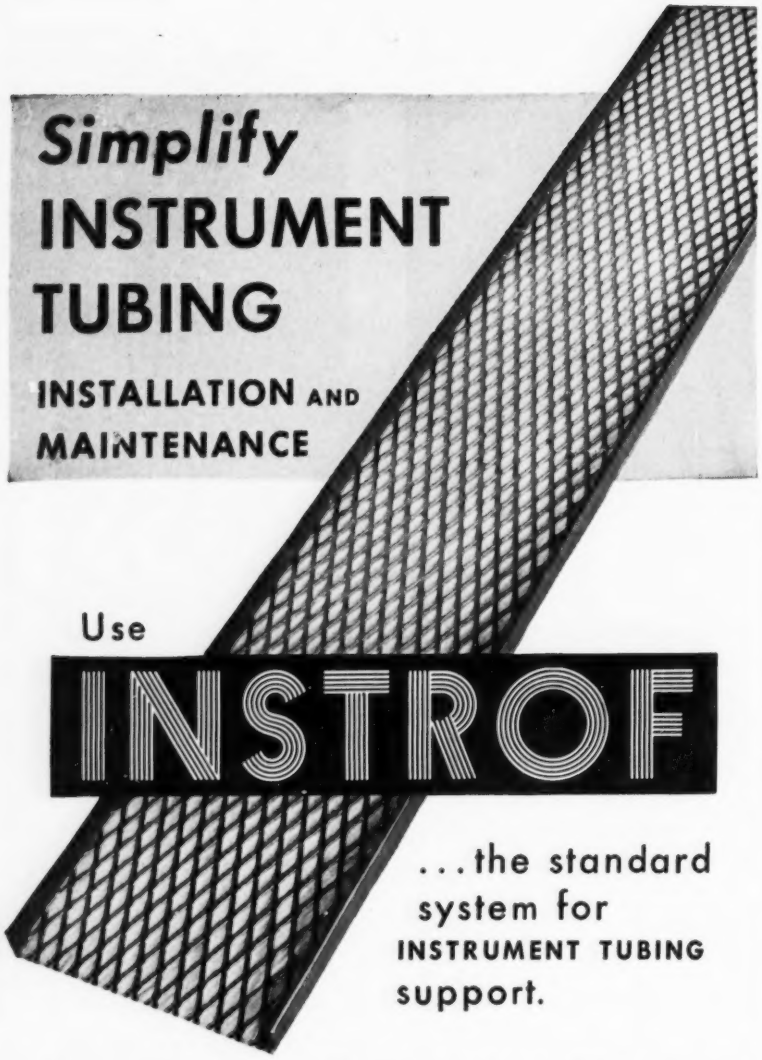
TYPE	DIALS	OHM STEPS	TOTAL RESISTANCE—OHMS	PRICE
542	1	0.01	0.1	$29.00
543	1	0.1	1	22.00
544	1	1	10	22.00
545	1	10	100	22.00
546	1	100	1,000	22.00
547	1	1,000	10,000	24.00
548	1	10,000	100,000	26.00
549	1	100,000	1,000,000	36.00
550	1	1,000,000	10,000,000	66.00
840	2	0.1	11	34.50
841	2	1	110	40.00
842	2	10	1,100	40.00
843	2	100	11,000	40.00
844	2	1,000	110,000	45.00
817	3	0.01	11.1	60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
817-B	5	0.01	1,111.1	94.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00

ACCURACY OF INDIVIDUAL RESISTORS:
0.01 ohm 5%, 0.1 ohm 1%, 1.0 ohm 0.25%, All Others 0.1%

SHALLCROSS MANUFACTURING COMPANY

Pusey & Lincoln Aves., Collingdale, Pa.

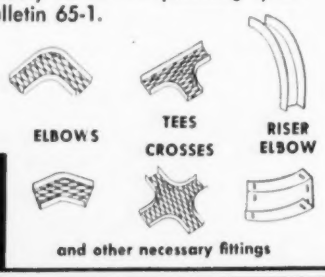
For more information circle **57** on inquiry card.



Now, you can simply and quickly assemble and erect a light but strong mechanical protection and continuous support for instrument tubing in new or old construction. Instrof, a proved system of prefabricated steel trough and fittings, is the modern, economical answer to this need. It is so versatile in application that with the use of standard fittings, changes in direction and elevation are made without difficulty.

Assembly requires only the use of nuts and bolts which are supplied. Complete Instrof system is hot dip galvanized for long life with minimum maintenance.

Experienced Instrof engineers will gladly assist in planning your installation. For full details write for Bulletin 65-1.



and other necessary fittings

INSTROF INCORPORATED

**4923 PENTRIDGE ST.
PHILADELPHIA 43, PA.**

For more information circle **58** on inquiry card.

close as 1 percent are available on order.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **317** on inquiry card.

Control Resistors

New "C-line" composition-element and wire-wound controls, for industrial, laboratory, and other semi-critical applications, are "deluxe" versions, mechanically and electrically, of maker's "Series 37" composition element. Electrical tolerances are 10 percent for composition element controls up to 100,000 ohms, and 20 percent from 100,000 ohms to 10 megohms. Wire-wound controls are within 5 percent in all resistance values. Independent linearity is to 1 percent for "58C" and "10C" controls; 2 percent for "43C" controls.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

For more information circle **318** on inquiry card.

Subminiature Resistor

New "Type A3606CG" resistor meets needs of sub-miniaturizing programs, is hermetically sealed, measures 3/16 in. diam. by 1⅛ in. long. Units are built to customers' specs, rated at 0.10 w., maximum resistance 500,000 ohms; tolerances down to 0.1 percent are standard. Axial lead wires of 22-gage tinned copper.—*Resistor Div., I-T-E Circuit Breaker Co.*, 1924 *Hamilton St., Philadelphia* 30, *Pa.*

For more information circle **319** on inquiry card.

Wire-wound Resistors

New "RB Series" precision wire wound resistors, in tolerances up to 0.02 percent, provide ratings of 1/4, 1/3, 1/2 and 1 watt in resistances ranging from 0.1 ohm. to 3 megohms; are stable mechanically from –55 C. to 105 C.; show less than 0.05 percent change in resistance after completion of MIL-R-93A tests.—*Reon Resistor Corp.*, 117 *Stanley Ave., Yonkers, N. Y.*

For more information circle **320** on inquiry card.

Wire-wound Resistors

New "Type SS-5" low-capacity precision wire-wound resistors are designed to meet low-capacity, matching requirements: 3 or 4 units that might require matching within 0.5 micromicrofarads; are said to be ideally designed for manufacturers and designers of test equipment, computers, etc. Units are also being manufactured in matched sets of four to meet capacity and temperature coefficient tracking requirements for use in h-f. bridges and high-repetition-rate computer circuits.—*Eastern Precision Resistor Corp., Richmond Hill* 18, *N. Y.*

For more information circle **321** on inquiry card.

High-temperature Capacitors

New "Polykane"-impregnated high-temperature metalized-paper capacitors, though small in size, require no temperature derating from –55 C. to

100 C.; through 130 C., 75 percent of rated voltage. Extended foils and securely soldered connections insure long life and low r-f. impedance. Three basic styles: metal cased "MTX" series, paper-cased "MPX," and "bathtub"-cased "SBX."—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

For more information circle **322** on inquiry card.

Subminiature Capacitors

New "Super K" subminiature ceramic capacitors are said to represent a new high in capacitance for size. A 0.1-mf. unit rated at 50 wvdc. may be obtained as small as 0.3 x 0.55 x 0.11 in. using multiple-plate formation; a 1500-mmf. capacitor rated at 200 wvdc measures approx. 0.12 x 0.12 x 0.08 in. Units intended for use at or about room temperature are made to shape and size required for each particular application. Sample orders filled within 2 weeks; production orders can be scheduled as requirements demand.—*Mucon Corp., 9 St. Francis St., Newark, N. J.*

For more information circle **323** on inquiry card.

Feed-through Capacitors

New "Type 112P Thru-Pass" high-current heavy-duty feed-through capacitors for use in suppressing r-f. interference have entire shell threaded except for two straddle milled flats; will not rotate and loosen under vibration. Their theoretical effectiveness is said to be realized in actual practice. Glass-to-metal solder seal terminals protect against atmospheric conditions from −55 C to 85 C. Working voltage, 250 v.ac.—*Sprague Electric Co., 343 Marshall St., North Adams, Mass.*

For more information circle **324** on inquiry card.

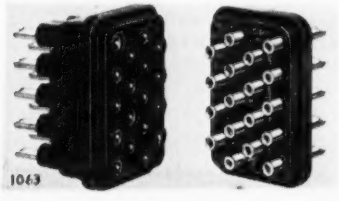
Standardized Sealed Lug-type Lead-through Insulators

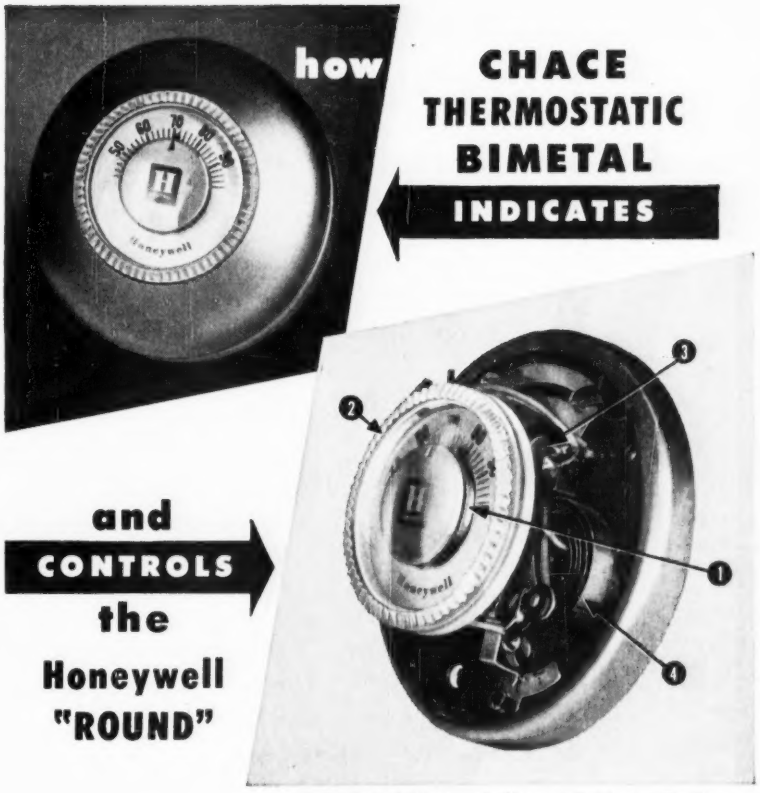
New hermetically-sealed lug-type lead-through insulators are available from stock in mass-produced economical standard types. Among features: ratings from 2000 to 4000 volts (rms); compression sealed; practically indestructible; mount from inside or outside of can; lead-through wires up to 0.060 in.—*Electrical Industries, 44 Summer Ave., Newark 4, N. J.*

For more information circle **325** on inquiry card.

18-contact Connector

New "MAQRE 18" miniaturized quick-disconnecting electrical connector is designed for heavy duty where space and weight must be saved without sacrifice of high current and voltage. Re-arrangement of





A Product of Minneapolis-Honeywell, Minneapolis, Minn.

The Honeywell Round, said to be the first really new idea in thermostats in years, uses a spiral thermostatic bimetal element to attain new precision in temperature control.

The Honeywell Round, announced to users in November, is but 3¼ in. in diameter; the outer shell may be lifted off easily for painting to harmonize with the walls. The outer pointer indicating the temperature of the room is actuated by a second coil of thermostatic bimetal (1).

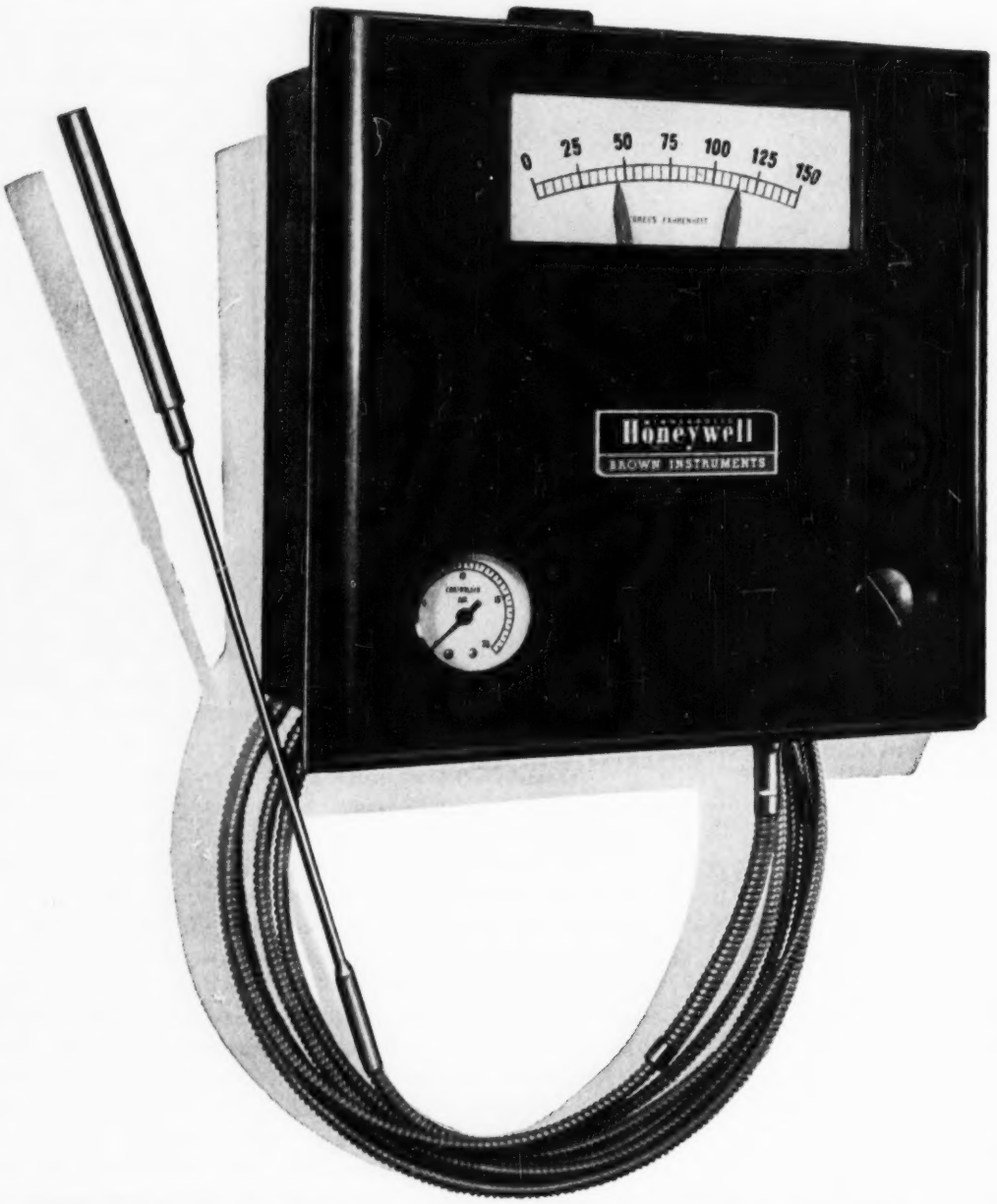
Adjustment for the desired temperature is made by turning the fluted plastic ring (2) in which is mounted the thermometer, past the pointer on the stationary center disc; thus it points to the desired temperature of the scale.

Movement of this ring also revolves the heat controlling unit consisting of a mercury switch (3) mounted on a larger coil of thermostatic bimetal (4). As the coil winds or unwinds with changes in temperature, it tilts the tube of mercury, allowing the mercury to close or open the heat controlling circuit. The mercury switch is dust proof, produces no exposed spark, and is noiseless.

This illustrates typical uses of Chace Thermostatic Bimetal as the actuating element for temperature responsive devices. If your product responds to, indicates or controls temperature changes, actuate it with dependable Chace Thermostatic Bimetal. Write today for our 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **59** on inquiry card.



Look at these features of the Model 604P5 Thermometer Controller

GOOD READABILITY:
indicates temperature on 4½" scale.

QUICK CONTROL CHECK:
readily visible red control pointer and black indicating pointer.

CONTROL AIR CHECK:
front-mounted gauge indicates air pressure to control valve.

VARIETY OF CONTROL:
direct or reverse acting pneumatic control —either on-off or proportional action.

SELECTION OF RANGES:
23 different temperature ranges, up to 1000°F., in Fahrenheit and Centigrade calibrations, for vapor and mercury bulb systems.

COMPACT DESIGN:
die cast aluminum case 11" x 11", 4" deep; gasketed black plastic cover; practically splashproof. Interchangeable flush or surface mounting on panels of any thickness.

SIMPLE SETTING:
external knob for adjusting control point.

A new, low-cost temperature controller *from Honeywell*

MANY processes which now use manual control can utilize the advantages of automatic operation at unusually low cost—by employing the new Brown Pneumatic Thermometer Controller.

For the scores of ovens, vats, dryers and similar equipment which need only temperature indication and relatively simple control, this new instrument affords excellent control performance. It's fast, accurate . . . and simple in design. It takes so little space that it can fit readily into existing equipment or on panels.

Instrument and thermal system are complete in one package. The set point is easily adjusted by means of an external knob. The selection of control actions, ranges and types of thermometer bulbs covers literally hundreds of control applications throughout industry.

In spite of its low price, this controller is a precision-built instrument which incorporates many of the long-lasting, high-quality components used in other Honeywell products. And it's backed by Honeywell's nationwide service organization, strategically located in more than 90 principal cities of the United States and Canada.

Our local sales engineer will be glad to discuss how this new controller can be applied to your own temperature problems. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

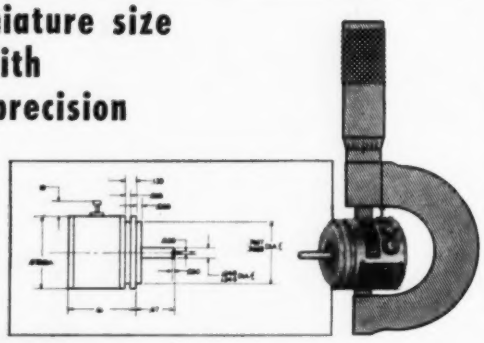
● **REFERENCE DATA: Write for your copy of new Bulletin 6401.**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information circle **60** on inquiry card.

(T) POT (R)

SUBminiature size with SUPERprecision



This new* TYPE 9** *(less than .9" dia.)* ***Ultra-Low-Torque

POTENTIOMETER by ELECTRO-MEC

offers designers and manufacturers of electronic equipment an opportunity to achieve greater miniaturization without sacrificing precision.

SPECIFICATIONS: **Length: single cup assembly .810"**
each additional cup .500"
Diameter: .875"
Shaft (ball bearing mounted): dia. .125"
Linearity: .5% (or less)
Ganged assemblies available.

For detailed information communicate with our Engineering Dept. or telephone STillwell 6-3402.

Available in Canada through Aeromotive Engineering Products, Montreal and Toronto.

Sales Representatives needed in several territories.

ELECTRO-MEC LABORATORY, INC. **21-09 43 Avenue Long Island City 1, N. Y.**

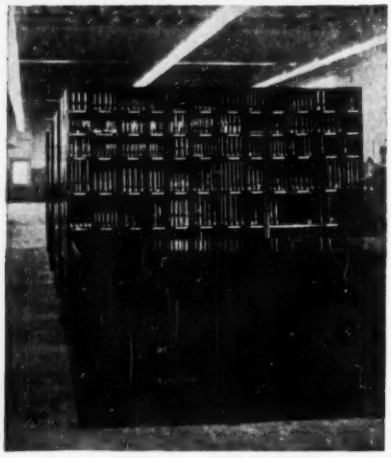
For more information circle **61** on inquiry card.

AVAILABLE *NOW!*

from Stock

TRINITY

THERMOWELLS



—in a wide variety of designs, sizes and materials.

We will be glad to place your name on the list to receive copies of the monthly Trinity Thermowell Stock List.

• ***Request your copy now.*** •

2106

TRINITY EQUIPMENT CORPORATION **494 Westfield Ave., East Roselle Park, New Jersey**
THERMOWELLS and other Specialties for the Process Industries

For more information circle **62** on inquiry card.

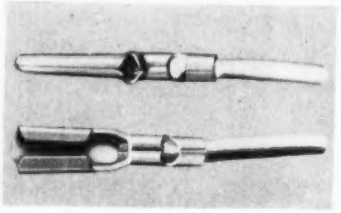
NEW INSTRUMENTS

contacts and omission of guides has resulted in a 35 percent space saving over comparable quick-disconnecting connectors having the same number of contacts. Voltage breakdown between contacts at sea level, 5400 v.dc.; at 60,000-ft. altitude, 1350 v.dc. Weight of receptacle, 1.8 oz.; plug, 1.1 oz.—*Winchester Electronics, Inc., Glenbrook, Conn.*

For more information circle **326** on inquiry card.

Solderless Terminals

New Taper Pin with mating receptacle and flat Taper Tab and Taper Tab Receptacle are self-locking terminals which eliminate terminal



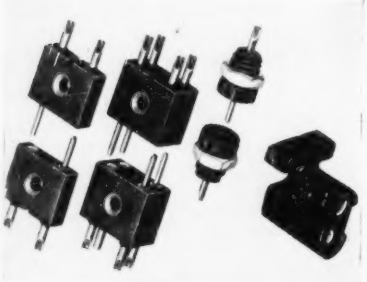
screws or soldering. Terminals, tandem mounted in strip form, are wound in reels for automatic application to

wire. An AMP Automatic Terminator (use of this machine is covered in purchase price of terminals) produces a controlled precision crimp. One user reports a 20:1 reduction in time and cost.—*Electronics Div., Aircraft-Marine Products, Inc.*, 2100 *Paxton St., Harrisburg, Pa.*

For more information circle **327** on inquiry card.

Special-design Connectors

New special-design connectors, added to "Continental Connector" line, comprise four types. Miniature rectangular 2- and 4-contact reverse pin and socket connectors have novel



countersunk side mounting arrangement, are also available in standard pin and socket arrangements. One-pin round connector is extremely small and light, can also be used as a disconnect type feed-through or standoff. Two-contact high voltage socket, of unusual shape, has close mating tolerances.—*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

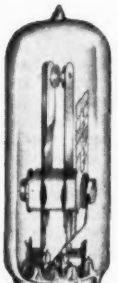
For more information circle **328** on inquiry card.

Wire Markers

New "Speedy-Marx Hi-Temp" wire markers resist temperatures to 400 F., are said to offer an identification marker system to a large group of users heretofore denied this simple means of identification: applications where temperature rise is considerable over ambient. Pressure sensitive tape is available in standard "Speedy-Marx" codes or can be made to user's size and specification.—*North Shore Nameplate Co., Glenwood Landing, L. I., N. Y.*

For more information circle **329** on inquiry card.

ELECTROMECHANICAL COMPONENTS



Delay Relays

New delay relays are available in T6-½ bulb-base 9-pin miniature, for all standard heater voltages. Delays from 2 to 90 seconds. Contact rating 2 amps, 115 v.ac. non-inductive. Compensated for ambient temperatures from −50 to 70C. Withstand vibrations.—*Amperite Co., Inc., 561 Broadway, New York 12, N. Y.*

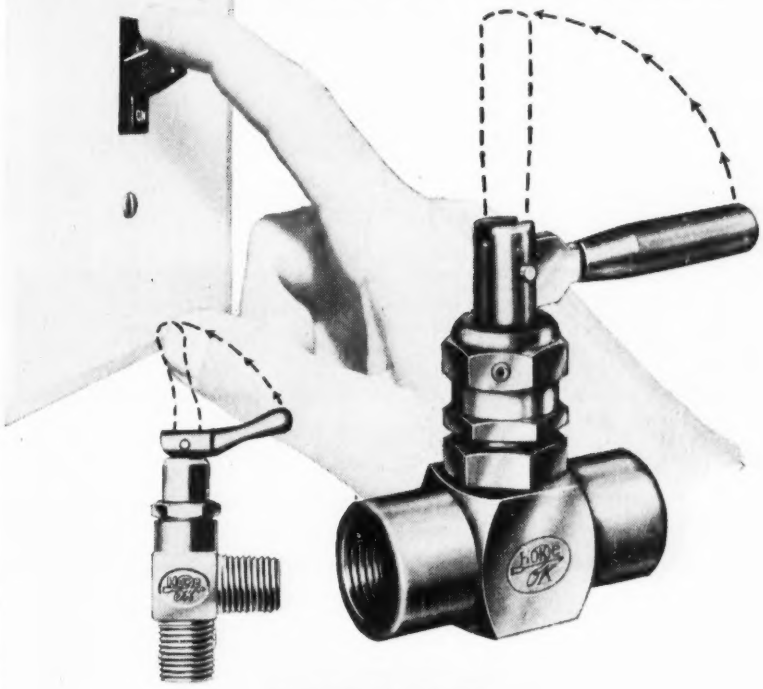
For more information circle **330** on inquiry card.

Ultrasensitive Relay

New "Capaswitch" ultrasensitive d-c. relay operates on 0.5 milliwatt-second and, according to announcement, "promises to be as revolution-

ary to relay design as the transistor was to vacuum tubes." It utilizes a new operating principle to provide mechanical energy to open and close contacts: instead of conventional electromagnetic armature, a unique electrostrictive capacitive element (0.05 microfarad) requiring 0.5 milliwatt-seconds of operating power (150 v.dc.) to close contacts, and less than 0.1 milliwatt to hold them closed (in many cases, one-hundredth of power required to keep a conventional magnetic-coil relay closed). Electro-

FOR Fingertip FLUID CONTROL



HOKE TOGGLE VALVES

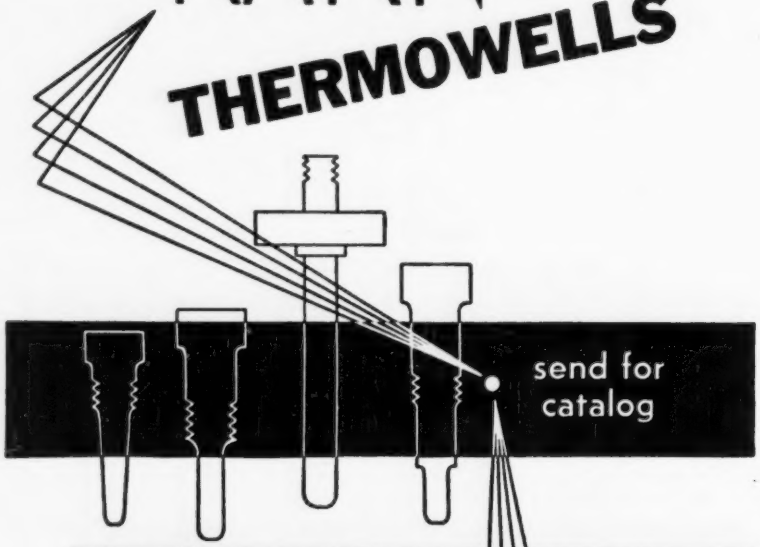
Opened or closed with a single, positive motion—like a light switch—these HOKE toggle valves will improve the design of your instrument panel or test stand. Use them to control gas or liquid, at pressures up to 1000 psi or in high vacuum, with no leakage through stem or seat. They are available in ⅛", ¼", ⅜" and ½" sizes, in brass or stainless steel. The seat material, normally synthetic rubber, may be altered to meet specific conditions. Both straight line and angle type are ideal for instrument panel installation and can be mounted easily and securely with a lock nut. Several types are available with plastic knobs of various colors, for quick identification of fluids. For fingertip fluid control—for time-saving, dependable, efficient performance—specify HOKE Toggle Valves. Write Hoke Inc., 231 S. Dean St., Englewood, N.J., for Catalog & Data Sheets.

HOKE

HOKE INCORPORATED
Fluid Control Specialists
ENGLEWOOD, NEW JERSEY

For more information circle **63** on inquiry card.

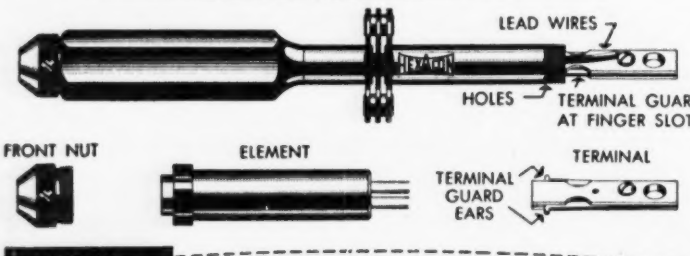
KARN
THERMOWELLS



KARN · CHEMICAL · EQUIPMENT · COMPANY
518 DICKSON AVENUE · PITTSBURGH 2, PA.

For more information circle **64** on inquiry card.

NOW! CHANGE SOLDERING IRON ELEMENTS IN A JIFFY!
with HEXACON
*Patent Applied For
Readily Removable Terminal* does the trick!



ALSO NEW!
BRASS-SHEATHED ELEMENTS
Easier to replace—Better Protection

Quick-change terminal can be removed in a second or two, permitting replacement of element in a fraction of the usual time. By simply depressing terminal guard at the finger slots, the terminal comes out in a jiffy—no longer necessary to fish element lead wires around terminal.

Write for catalog showing 40 industrial soldering irons of every type and size; there is no obligation.

HEXACON—Industry's No. 1 Soldering Iron

HEXACON ELECTRIC COMPANY
179 W. CLAY AVE., ROSELLE PARK, NEW JERSEY

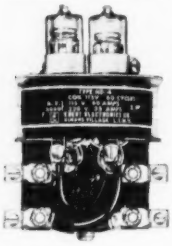
For more information circle **65** on inquiry card.

static element may also be used to store minute amounts of energy from a low-energy source until enough has been accumulated to operate relay. To open contacts, voltage is removed and electrostatic element is discharged through other circuit elements or a resistor. Low operating power requirement permits even a phototube to operate relay directly, without an amplifier tube. Input resistance of electrostatic element is about 100 megohms. "Capaswitch" has a normal closing delay of about 10 milliseconds, is actuated by electrical pulses as short as 10 microseconds or less. A 300-percent overvoltage may be applied to electrostatic element without damage. Heat dissipation problems are virtually eliminated. Present unit ("Model A") weighs 2 oz. including molded plastic case; is s-p.d-t. with 1-amp 110 v.ac. non-inductive) rating, is available in limited quantities. Other models in the near future.—*Mullenbach Electrical Mfg. Co. 2300 East 27th St., Los Angeles 58, Calif.*

For more information circle **331** on inquiry card.

Heavy-duty Mercury Relay

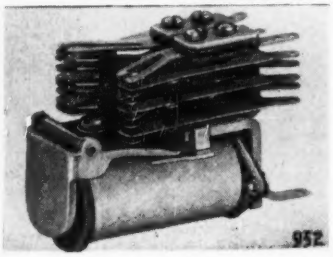
New "HD-4 Mercury Contactor," for heavy-duty control applications features mercury-to-mercury contacts; is silent and explosion-proof; requires no maintenance. It is a two-tube contactor: each tube will control 60 amp. at 115 v. ac., 35 amp. at 230 v. ac., and 12 amp. at 115 v. dc. For motor control, 2 hp. at 115 v. ac., 3 hp. at 230/440 v. ac. and ½ hp. at 120/220 v. dc. Coils are available for a variety of control voltages. "HD-4" is available with both tubes n-o. or n-c.; also with one n-o. and one n-c.—*Ebert Electronics Co., 212-26 Jamaica Ave., Queens Village 28, L. I., N. Y.*



For more information circle **332** on inquiry card.

Relays

Newly developed line of relays is said to have exclusive features for each class of relays, examples being as follows: Bearings of "Series 100"



d-c. computer relays have essentially zero friction and relay has a life span of ten million cycles; "Series 300" d-c. miniature relays weigh under 2 oz. and are exceptionally resistant to

vibration and shock; "Series 400" d-c. or a-c. coaxial relays withstand 10 *G* vibration at 10-55 cps. under operation tests; "Series 500" d-c. communication relays can perform mechanical work in addition to operating contacts, as in applications where automatic punching is required for control system applications.—*Joseph Pollack Corp.*, 81 *Freeport St., Boston* 22, *Mass.*

For more information circle **333** on inquiry card.

Miniature Motor

New miniature d-c. motor for aircraft use is 1⅝-in. in diam. and 2¾ in. long, weighs approx. 8 oz.; is rated 0.002 hp. at 6500 rpm.; contains more than two miles of 0.002-in. wire.—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **334** on inquiry card.

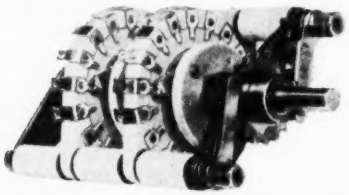
Miniature Motors

New miniature hysteresis-synchronous motors for 400-cps. applications are well adapted for power, servo or timing applications; are 1¼ in. dia. by 2¼ in. long; available with two-pole or four-pole windings, for 24,000 or 12,000 rpm. For servo applications, motors can be wound for two-phase operations; for timing and power applications they are available as single-phase capacitor-run motors. Maker's standard gear reducers, both spur and planetary, can be furnished with these motors as combined package, whence a great range of available output speed and torque.—*Globe Industries, Inc.*, 1784 *Stanley Ave., Dayton* 4, *Ohio.*

For more information circle **335** on inquiry card.

Selector Switch

New "Brown-Hill" low-loss 18-position ceramic wafer-type selector switch for use where resistance, inductance and capacitance must be minimized, has a voltage break-down



of 4000 v. ac.; capacity of 30 amps. non-inductive load. Available in 1 to 6 gangs, new switch features a new, 20-deg. positive detent mechanism with adjustable stops. Its rotor blades and stator contacts are of solid pure silver, entirely eliminating switching noise. Rotor contact segments do not depend on rivets to carry current.—*R-F Electronics, Inc.*, 291 *N.E. 61st St., Miami, Fla.*

For more information circle **336** on inquiry card.

Push-button Switches

New "Series W100" moistureproof momentary-contact snap-action push-button switches designed to meet Mil-S-6743 specs may be ordered with various adapters to meet practically all front-of-panel, back-of-panel, edge-

precision electronic instruments by DeJUR
1½" SQUARE
WATERTIGHT
Panel Meter
.5
DC
1.0
MILLIAMPERES
ACTUAL SIZE
• From 1 to 100,000—DeJUR's 1½" meter sets the world's standard for quality, performance
• Available with 2 terminal designs
1. Solder terminal
2. 4-40 screw terminal
• Multi-color or luminescent scales and pointers
• Proven external pivot D'Arsonval movement
• From prototype to production on short notice
For further information write DeJUR-Amsco Corporation, Dept. IM-12, 45-01 Northern Boulevard, Long Island City 1, New York
ELECTRONIC
DeJUR
U.S.A.
INSTRUMENTS
YOU'RE SURE WITH DeJUR
POTENTIOMETERS • CONNECTORS • METERS
DeJUR AMSCO CORPORATION
45-01 NORTHERN BLVD., L.I.C. 1, N. Y.

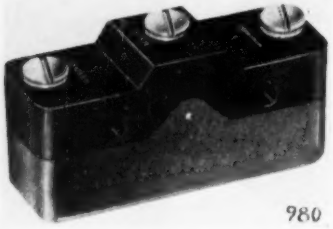
For more information circle **66** on inquiry card.

lit panel, blind hole, or force-fit mounting requirements; in commonly-used circuit arrangements; current ratings 10 amps. resistive, 5 amps. inductive, and 3 amps. lamp.—*Hetherington, Inc., Sharon Hill, Pa.*

For more information circle **337** on inquiry card.

Snap-action Switches

New models of maker's snap-acting switches have electrical connections simplified by new base which provides terminals sturdy enough to suit wiring practices for circuits handling the



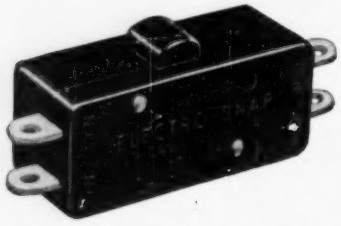
980

17 amperes at which these switches are listed by Underwriters' Laboratories, Inc. New base carries clear markings that identify the n-o, n-c., and common contacts.—*Unimax Switch Div., The W. L. Maxson Corp., 460 W. 34th St., New York City.*

For more information circle **338** on inquiry card.

Snap-action Switch

New "hammer-blow" snap-action switch, for use in severe vibration applications or with slow-moving cams and pressure operated devices, main-



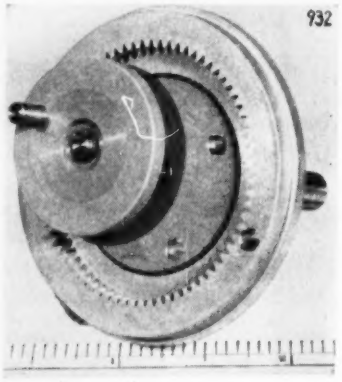
tains contact pressure of at least 45 grams until instant contacts snap over. Contacts snap over with "hammer-blow" 150 to 200 grams contact pressure, reducing arcing and increasing electrical capacity. Rated at 15 amps, 125/250 v.ac. or 30 v.dc., switch is s-p. d-t. with four terminals and two separate circuits in space-saving size (1½ in. long). It is also available in a reset model which, when actuated, holds contacts in one position until a second button is pushed (recommended for over-limit safety uses and for reversing control). Switch may be used with or without an actuator, depending on over-travel required. Available actuators include lever, leaf, push button and toggle types.—*Electro-Snap Switch and Mfg. Co., 4200 W. Lake St., Chicago 24, Ill.*

For more information circle **339** on inquiry card.

MECHANICAL COMPONENTS

Sine-cosine Mechanism

New "Sine-Cosine Mechanism," a new type of component for analog computers, converts angular rotational movements into linear

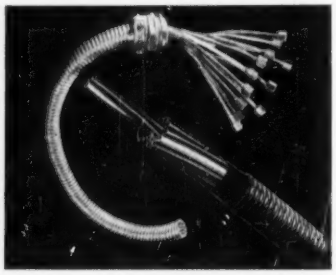


(±0.750 in.) sine or cosine movements. Features include positive preset indexing (3 position 90 deg. apart) and conventional 3-lug arrangement for mounting. Weight 2 ozs.; accuracy 0.2 percent of full scale.—*Librascope, Inc., 1607 Flower St., Glendale, Calif.*

For more information circle **340** on inquiry card.

Cabled Tubing

New "Armored Multitube" permits making savings on moderate to long runs of numbers of ½-inch and smaller tubes. Tubes are twisted to-

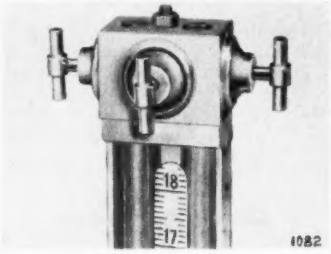


gether to permit bending without distortion and are protected by galvanized steel armor. One tube in each layer is bright blue, for ready identification of each tube at both ends: position of each tube in each layer, with respect to blue tube in that layer, remains the same throughout any length of "Armored Multitube." Two to nineteen ¼-in. O.D. copper and aluminum tubes are normally available from factory stock, in continuous lengths up to 1,000 ft. Tubes are also available in polythylene and other plastics.—*Crescent Insulated Wire & Cable Co., Trenton, N. J.*

For more information circle **341** on inquiry card.

Packless Manifold

New "Demi-34" packless manifold provides a 3-valve manifold with 4 connections. (In manometer application shown, only two pipe connections

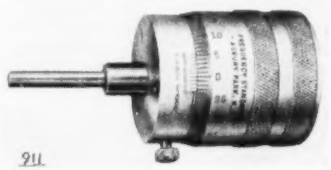


are required, the other two are sealed between body and glass tubes with special rubber grommets.) Assembly consists of two shut-off valves and one by-pass valve. Arrangement reduces the number of connections for three separate valves and fittings from 12 to 2. Body available in brass, anodized aluminum, steel or stainless steel. All units have stainless steel diaphragms and integral seats.—*G. W. Dahl Co., Bristol, R. I.*

For more information circle **342** on inquiry card.

Micrometer Head

New micrometer head for electronics industry features elimination of back-lash, which assures positive resetting in either direction of rotation



911

and automatically compensates for wear of spindle and nut thread; easy to read graduations; temperature compensation construction; thimble stop to prevent thread jamming; positive spindle lock; easy resetting for calibrated instruments; vernier scales in either Metric or English units. Available in 0.5-in. and 1-in. travel.—*Frequency Standards, P. O. Box 504, Asbury Park, N. J.*

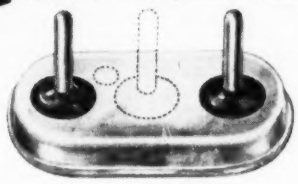
For more information circle **343** on inquiry card.

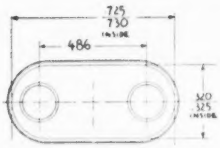
Miniature Roller Bearings

New "RMB types N. NU and NP," the first miniature roller bearings commercially available in this country, are available in seven sizes from 0.4724 in. to 1.0236 in. OD. All three types are suitable for use in apparatus, motors, etc., where shafts are subjected to heavy radial loads. All permit some axial displacement of shaft, hence speedier assemblies. Roller assembly is retained by a snap-ring on inner race and a section of shield at outer race. This new method

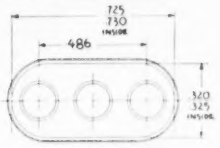
FUSITE CRYSTAL CAN HEADERS

1500 V (RMS)

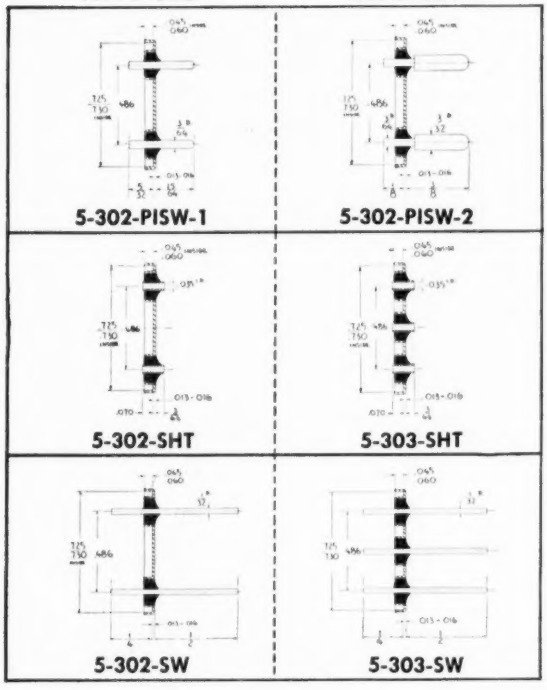




No. 5-302



No. 5-303



Fusite's design of Crystal Can Headers combines the ruggedness of a metal base with large size glass areas surrounding the electrodes, assuring a safe rating of 1500 V(RMS). Several of the terminals shown are available with attached crystal springs to your specification. They fit standard crystal cans. As an optional feature these terminals can be furnished with adjusting hole for thermostat applications.

Write for FREE samples to Dept. J-6

FUSITE TERMINALS — INSULATE ELECTRICALLY · GLASS TO METAL · PROTECT PRODUCT PERFORMANCE · SEAL HERMETICALLY

THE FUSITE CORPORATION
6000 FERNVIEW AVENUE
CINCINNATI 13, OHIO

For more information circle **67** on inquiry card.

for Calibration, Precision Indicating...

MERIAM MICROMANOMETER for Readings to .001"

Here is the answer to many of those calibration problems! Accurate and easy to use — by even the inexperienced — this highly sensitive Meriam Micromanometer is designed for highly critical calibrations. This precision instrument may also be used to indicate differential pressures in systems operating at static pressures up to 15 psi.

Utilizing the "null balance" principle of operation, a known pressure value is balanced against the value to be measured. All readings are made at a zero reference point. No correction for fluid displacement is needed.

Write for Bulletin 25.

THE MERIAM INSTRUMENT CO.
10990 Madison Avenue • Cleveland 2, Ohio
WESTERN DIVISION: 4760 E. OLYMPIC BLVD., LOS ANGELES 22, CALIF.
IN CANADA: PEACOCK BROS., LTD., MONTREAL

MERIAM Instruments
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **68** on inquiry card.

of construction eliminates lip on either raceway; permits production of a perfectly cylindrical race and a superfine finish on latter's rolling surface. "Type N" permits free axial displacement of shaft and easy removal of shaft, inner race and roller cage as a unit. In "Type NU," inner race remains on shaft; outer race, rollers and roller cage may be removed as a unit. In "Type NP," outer and inner races are permanently assembled. "Types N and NP" carry removable dust shields. Experimental quantities available immediately.—*Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.*

For more information circle **344** on inquiry card.

VALVES

Hydraulic Pilot Valve

New "V10-1000 Miniature Hydraulic Valve" can be utilized as a two- or three-way valve in either normally open or closed positions, handles up to 1000 psi. pressures. Principal application: automatic operation of single- and double-acting hydraulic cylinders or for pilot control of large three- and four-way hydraulic valves. All internal parts are stainless steel; slide mechanism has a precision-ground piston and a bore held to extremely close tolerances to make possible guaranteeing a minimum leakage factor. Other specs: 1/8-in. NPT threaded ports, effective orifice diameter of 3/32-in.; availability for the full range of a-c. and d-c voltages. —*Skinner Electric Valve Div., Skinner Chuck Co., Edgewood Ave., New Britain, Conn.*

For more information circle **345** on inquiry card.

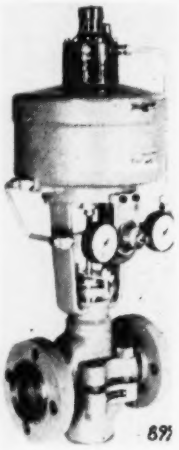
Depressurizing Safety Valve

New "Remotor" is designed to rapidly depressurize pressure vessels in event of an emergency and to also function as an "unloader" for those applications where unloading feature can be combined with a safety valve. Depressurizing component of "Remotor" is interchangeable and can be readily mounted on maker's other safety valves, already installed. Among features: (1) operation by air pressure from remote points; (2) rapidly depressurizing vessels in service to predetermined limit or to 0 psig.; (3) safety-relief and drop-out service in one installation; (4) extra-power air motor: one regulated power supply for a series of valve installations; (5) weather-proof, maintenance-free operation; (6) normal use of test lever.—*Farris Engineering Corp., 610 Commercial Ave., Palisades Park, N. J.*

For more information circle **346** on inquiry card.

Control Valves

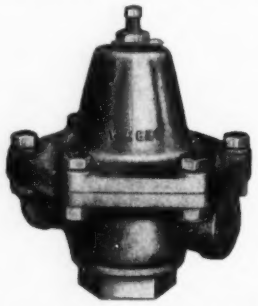
New "LB Series" control valves feature "an entirely new concept of valve topworks," and a completely new single-seated split-body valve design. Topwork comprises an aluminum cylinder with bored and honed internals, a plastic piston with graphite-impregnated O-ring seal, and an integral positioner that permits static or cushion loading pressure to be in either upper or lower cylinder chamber. Coupled with reversible "Conoplug," it is said to permit any possible combination of forces to cope with unbalanced loads, and/or requirements for pre-determined plug positions on loss of operating air pressures. Positioning accuracy is better than one part in 1000 of instrument output span. Available in sizes up to 4 in. and for Series 15, 30, and 60 body ratings. Bodies available as standard in carbon steel, bronze, aluminum, 316 stainless steel, Hastelloy, Durimet and a number of semi-standard alloys. Various trim materials, including non-metallic seating surfaces. Angle type bodies and straight-through designs. Special features for extraordinary services available on order.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*



For more information circle **347** on inquiry card.

Reducing Valves

New "Type BBC" automatic pressure reducing and regulating valves, intended primarily for use on bunker "C" oil service, as well as other dirty

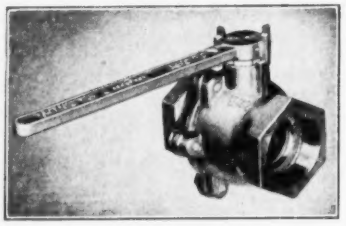


liquids or fluids with a high viscosity, are of direct-acting single-seated spring-loaded-diaphragm type, self-contained, with simple pressure adjustments. Inner valve and valve seat are both renewable. Owing to new design contour of piston seat (substantially a "universal joint" arrangement) valve will close off well under practically all operating conditions. —*A. W. Cash Valve Mfg. Corp., Decatur 60, Ill.*

For more information circle **348** on inquiry card.

Ball Valve

New lever-operated valve features floating chromium-plated bronze ball with full round port which, when open, is continuation of pipe: nothing

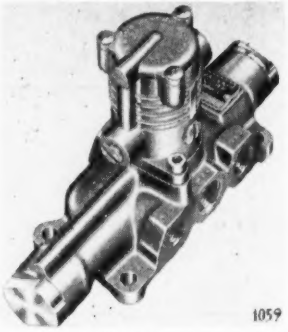


to create turbulence. Among claimed advantages for instrument applications: Tight; long lasting; shut-off; quarter-turn; handle indicates degree of closure and permits instant open or closing. Valve acts as an automatic relief valve in reverse flow to vent fluids trapped in gages. Rated pressure 300 psi.; guaranteed tight up to 1500 psi. Adaptable for remote controls, mechanical sequence problems, etc. 100 percent inspection at factory. —*Rockwood Sprinkler Co., 38 Harlow St., Worcester 5, Mass.*

For more information circle **349** on inquiry card.

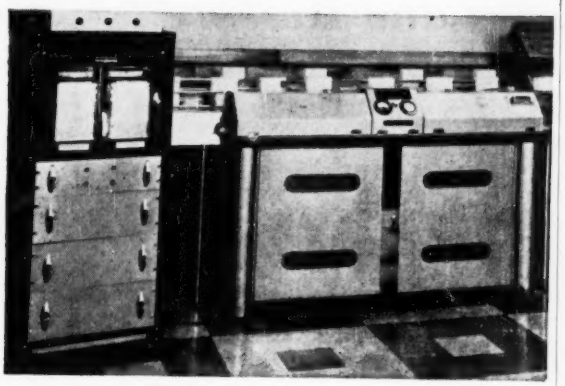
Solenoid Pilot-operated Valves

New "Speed King" line of solenoid pilot-operated air control valves comprises thirty units, available for 3-way, 4-way and 4-way 5-port (two-



pressure) application in pipe sizes ¼ in. through 1 in. All types and sizes furnished either for foot mounting or sub-base manifold mounting in accordance with JIC specifications. Minimum life expectancy exceeds 20,000,000 cycles. Spool is only moving part of main valve body. An optional manual override is available for pilot valve, which makes operation possible when electric current is off or when cylinder control set-ups are of importance. Solenoid coil is replaceable and is available in any a-c. and d-c. requirements. Maximum power consumption at any voltage is 10 watts, assuring cool operation and long life at operating speeds as high as 600 cycles per minute. Solenoid can be energized for any length of time without overheating. All models are for air pressure from 35 to 150 psi. and for low pressure oil hydraulic service.—*Valvair Corp., 962 Beardsley Ave., Akron 11, Ohio*

For more information circle **350** on inquiry card.



Measure . . . Compare . . . Correct . . .

MEASURE your entire production output—eliminate doubtful "sampling." The SELECTROL checks *every* unit produced. It automatically weighs, classifies, sorts, and records.

COMPARE every unit produced and learn immediately the range and average of units *as they are produced*. The Average and Range Control Plotter records each production unit as it flows over the SELECTROL.

CORRECT your filling machine settings. Eliminate your assignable causes rapidly.

The SELECTROL Automatic Checkweighing Machine is designed for direct insertion into your production line. It's a time-proven production machine in use on hundreds of industrial production lines. Send coupon today for complete details.

Exact Weight Scales

Better quality control
Better cost control

THE EXACT WEIGHT SCALE COMPANY

951 W. Fifth Avenue, Columbus 8, Ohio
2920 Bloor St., W., Toronto 18, Canada

Please send SELECTROL bulletin

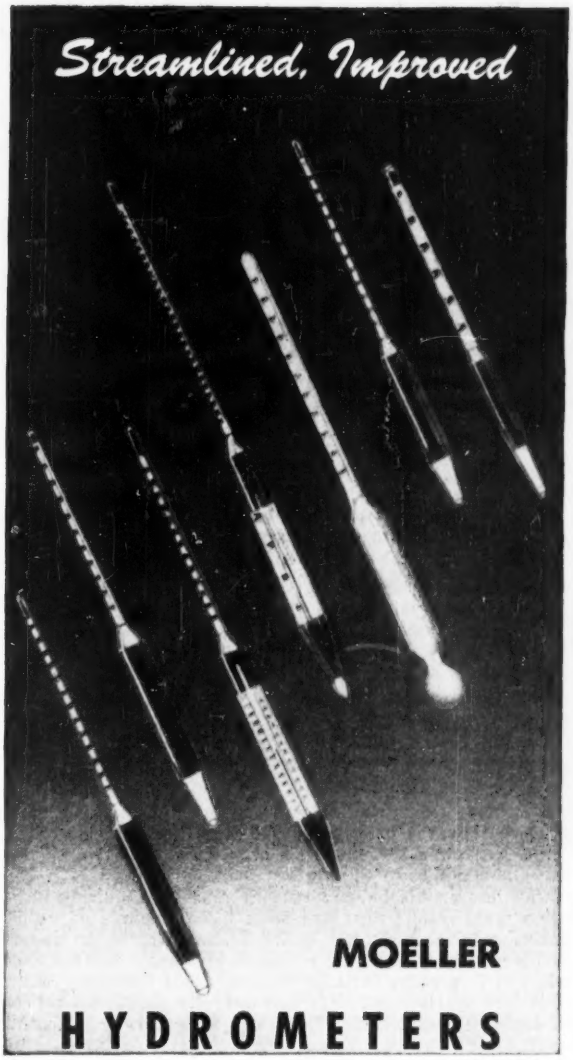
☐ Literature only ☐ Have representative call

Name .....

Address .....

City ..... Zone ..... State .....

For more information circle **69** on inquiry card.

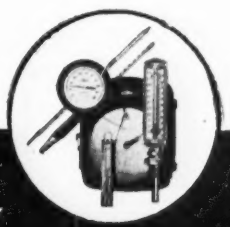


. . . for quickly and accurately determining the density of light and heavy liquids. Made in a variety of scales, such as Brix, Twaddle, Ballings, A.P.I., etc. Specific Gravity, Baume, etc. Plain form or combined with thermometer. They are unfailingly correct.

Write for special Hydrometer Catalog today!

Send for catalogs and literature on

INDUSTRIAL, LABORATORY AND RECORDING THERMOMETERS
VACUUM GAUGES • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
AND MARINE SPECIALTIES



MOELLER
INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

For more information circle **70** on inquiry card.

Nuclear Reactors for Industry and Research

Fig. 4-1. A "basic laboratory" for quantitative studies on all radioisotopes. It consists of a fusion-seal mica-window counter, a lucite mount, a vertical iron shield, aluminum sample pans, a radioactivity warning placard, and a scaler.

IV RADIATION P

A radiation protection program requires (1) knowledge of maximum permissible exposure levels, (2) adequate and properly arranged working facilities, (3) survey and monitoring instruments, (4) waste disposal, and—of great importance—(5) an organizational program in the charge of a health physicist.

When universities consider the installation of nuclear reactors, they ask two questions: (1) Are nuclear reactors likely to be extremely dangerous to those who are using them for experimental purposes? (2) If so, what protection can be set up against reactors?

It will be reassuring to prospective purchasers to learn that the hazards of ionizing radiation are not essentially different from other numerous hazards associated with living and working in the modern industrial world. Man has always been subjected to a certain amount of ionizing radiation from cosmic rays and from trace amounts of radioactive material in the soil, in the air, and even in the tissues of his own body. Ionizing radiation becomes a menace only when it is present in large amounts, and then only when it is improperly controlled. The uniquely dangerous aspect of ionizing radiation is that man's senses do not respond to it. Consequently, through ignorance, carelessness, or negligence, he may suffer a severe overexposure which, although it does not produce a sensation of pain at the time, nevertheless may result later in disastrous consequences. However, the fact that thousands of persons on the United States Atomic Energy projects have worked with ionizing radiation for years without sustaining radiation injuries, and have set a safety record higher than the safety records of most major industries, attests the fact that researchers can work safely with ionizing radiation.

The remarkable safety record referred to is the result of an elaborate health physics program which consists of (1) the establishment and maintenance of safe levels of maximum permissible exposure, (2) the availability of properly designed buildings and working facilities, (3) the furnishing of adequate laboratory equipment, (4) the development and continuous use of suitable survey and monitoring instruments, (5) the satisfactory disposal of radioactive waste material, and (6) the training of personnel so that they have a proper alertness to and understanding of ionizing radiation.

A health physics program of radiation protection is essential in the university or smaller research laboratory that is using high-voltage accelerators and radioisotopes, and that may be considering a research reactor. The requirements for radiation protection, from the standpoint of effort and cost, are much less than in a large Atomic Energy Commission operation, but they are just as important to the success of the operation.

Maximum Permissible Exposure Levels

The standards of radiation protection (for the safe operation of high-voltage equipment and reactors, for the proper handling of radioisotopes, and for the disposal of radioactive waste) and the recommended levels of maximum permissible exposure to external and internal sources of ionizing radiations are set by the National Radiation Protection Committee. The handbooks of this committee that deal with these subjects are issued by the National Bureau of Standards and may be purchased for a few cents each from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Table 2.—Maximum Permissible Tissue Dose Limits

Type of Radiation	*At a Point Within the Body (rep/wk)*	*Permissible Surface Dose*		*Permissible Flux for Indicated Energy (For 8 hours exposure per day, 5 days per week.)*
		Any Surface of Body (rep/wk)	*Exposure to Hands Only (rep/wk)*	
X and Gamma	0.3	0.5	1.5	3900 photons/cm.^{2} sec. for 1 Mev
Beta	0.3	0.5	1.5	50β/cm.^{2} sec. for 1 Mev max.
Alpha	0.015	0.025	0.075	0.009α/cm.^{2} sec. for 5 Mev
Fast neutrons	0.03	0.05	0.15	40 neutrons/cm.^{2} sec. for 2 Mev
Thermal neutrons	0.06	0.1	0.3	1800 neutrons/cm.^{2} sec. for 0.02 Mev

By KARL Z. MORGAN
Oak Ridge National Laboratories

PROTECTION

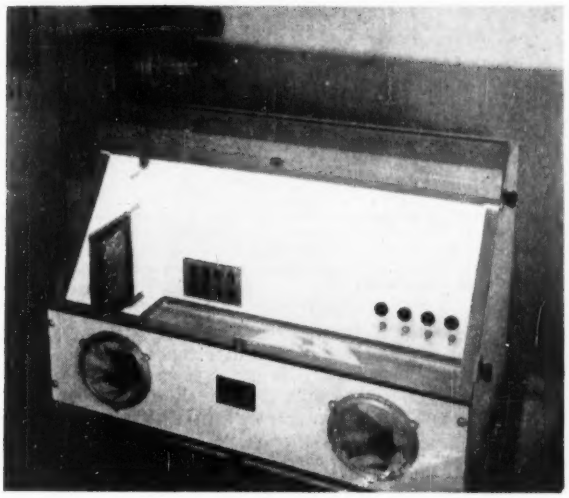


Fig. 4-2. Danger from radioactive dust in laboratory air can be largely eliminated by carrying out transfer operations in these dust-tight safety chambers, which completely enclose the dust normally resulting from the transfer of radioactive solids and powders.

There are two types of exposure to ionizing radiation—external and internal. The presently accepted levels of maximum permissible exposure are given in Table 2.

When radioactive contamination is discharged into the air or into public water systems where it can be taken into the body, care must be taken to maintain the concentration below the maximum permissible values. One of the handbooks issued by the National Bureau of Standards gives maximum permissible concentrations (MPC) values for about seventy-five radioisotopes. It also gives the general MPC values shown in Table 3. In a university laboratory where a limited variety of radioisotopes is being used, it usually is not necessary to go through the laborious procedure of identifying the individual radioactive contaminants in the water and air discharge from the institution. It is possible to make certain that the air and water in the laboratory are safe for human consumption and conform with recommended practices in the discharge of radioactive waste simply by seeing to it (with the use of appropriate instruments) that the gross contamination in the air and water does not exceed the values given in Table 3.

In applying the maximum permissible levels given in Tables 2 and 3 to the operating area about a high-voltage accelerator or a nuclear reactor located on a university campus, the question arises as to what additional safety measures should be applied. The answer is that it is good practice not to permit *any* radiation exposure which can be avoided without undue inconvenience and expense. The shielding should be designed so that the average dose rates in the laboratories and operating areas are less than 1/100 of those given in Table 2, and the ventilating system should be such that the average air contamination in the buildings is less than 1/100 of the values given in Table 3. This precaution is taken primarily to keep the general level of radioactive contamination in the university low enough not to interfere with radiation detection experiments, trace experiments, radiation instrument development work, etc.

TABLE 3.—GENERAL LEVELS OF MAXIMUM PERMISSIBLE CONCENTRATION OF RADIOACTIVE CONTAMINANTS IN AIR AND WATER

Medium in Which Contained	*Beta or Gamma Emitter* ($\mu c/cc$)	*Alpha Emitter* ($\mu c/cc$)
Air	10^{-9} (1)	5×10^{-12} (2)
Water	10^{-7}	10^{-7} (3)

The values in Table II are considered safe for any of the radioistopes if (1) is reduced to 0.2×10^{-9} for Sr^{90}; if (2) is reduced to 2×10^{-12} for Pu^{239}; and if (3) is reduced to 0.4×10^{-7} for Ra^{226}.

The personnel-protection requirements are less stringent, but it is the usual recommended practice to keep the average exposure rates to personnel over a period of years to less than 10 percent of the values listed in Table 2.

If contaminated air and water are to be discharged into the environment of the university for many years (more than ten years) it is recommended that the values in Table 3 be reduced by a factor of 10.

LABORATORY BUILDINGS AND WORKING FACILITIES

No radiation-protection program can be completely successful unless the buildings and laboratory facilities are adequate. The building should be arranged so that the "hot" work is at one end, and the tracer-work and low-background counting rooms at the other.

If the *counting room* is located 100 feet or more from the so-called "hot" laboratories, it usually is not necessary to build concrete counter-room walls of one-foot thickness; local lead or iron shields about the counting units (Fig. 4-1), or iron bricks stacked and braced about the counters provide sufficient shielding.

The counting room should be located as far as possible from high-voltage equipment, generators, high-voltage transformers, etc., in order to minimize electrical-disturbance interference with the counting equipment. All 110-volt circuits leading into the counting room should be brought through metal conduits that are grounded properly. In universities where the counting room is located close to high-voltage equipment, it is necessary to line the walls and floor completely with wire netting that forms a Faraday cage of the room. The counting room should be air-conditioned to maintain the equipment at the proper temperature and humidity. If certain types of sensitive counting equipment, such as proportional counters, are used, it may be desirable to cover the walls with sound-proofing material.

Change-room facilities with lockers, showers, and toilet space should be provided so that personnel can wear laboratory clothing in potentially contaminated areas. In addition, in each working area a room should be provided for the health physicist and for the storage of his instruments.

If considerable work is to be done with gamma-emitting radioisotopes, single-storey buildings are preferable but are not required for the small quantities handled in university laboratories. The laboratories should be well ventilated with once-through air that flows from the offices and hallways into the laboratories and out the hoods or ceiling vents. The ventilating system must be constructed so that air never can flow down the hood exhaust and into

Fig. 4-3. Stainless-steel safety tray prevents dangerous contamination of surroundings in event of accidents while working with radioactive isotopes. Experimental equipment is set up in the containing tray; its 2-inch rim prevents splashing and spreading of radioactive solutions coming from broken glass flasks, tubes, etc.

the room, in any circumstances. The linear flow of air into the hood should not be less than fifty feet per minute. Each hood should be specifically designed for radioisotope work, with properly placed airfoils about its face and with devices which prevent the placing, near the front of the hood, of objects that might disturb the uniform airflow into the hood. All unnecessary shelves and exposed pipes in the hoods (as well as in the laboratory) should be eliminated because they may serve as collectors of contaminated dust.

If radioisotopes are to be used in a laboratory, the floors, walls, ceiling, table top, hood surfaces, etc., should be covered with a smooth, hard surface that does not collect radioactive contamination readily and that can be decontaminated easily and effectively. Unpainted wood, concrete, plaster, porous paint, soapstone, etc., are examples of surfaces that are not recommended; ceramic tile, vinyl tile, asphalt tile, rubber tile, and linoleum are recommended—provided they are kept clean, waxed, and polished. Glass, masonite, and smooth-surfaced plastics are recommended for work surfaces. Painted surfaces should be covered with several coats of seal-coat and painted with one of the surface paints that have proved satisfactory for this purpose, such as Fluorothene, Polythene Duralon No. 35, Devon Resin K-5925, Vinyl Butyrol D-1000 strippable coat, or Cocoon strippable coat.

Laboratory Equipment

Every well-equipped radioisotope laboratory makes use of *glove boxes* or dust-tight safety chambers, such as those shown in Figure 4-2. These boxes are provided with sealed-in rubber gloves which extend into the chamber.

The boxes usually are provided with filters and a blower that is operated by a small electric motor so that the contaminated air is filtered before passing into the hood or roof ventilators. Furthermore, the air inside the box is maintained at a slightly negative pressure, which prevents leakage of air-borne contamination into the laboratory.

All the hoods and glove boxes should be provided with *metal trays* to help confine contamination (Figure 4-3). If radioactive materials are carried from one place to another in the laboratory, the metal pans or special metal carriers should be used. These containers have welded corners and are resistant to spills of hot hydrochloric acids. They are useful in accidents where quick removal of the "hot" equipment is required; the entire tray with the radioactive matter can be taken out of the laboratory immediately.

Heavy *blotting paper* should be spread over tables, hood tops, and on the floor in areas where work with radioisotopes is under way, to reduce further the spread of contamination in event of a spill.

Tongs, special remote-control handling devices, and mechanical holders, such as shown in Fig. 4-4, must be provided for work with millicurie amounts of beta or gamma activity. Leaded gloves are useful for work with small amounts of gamma-active material, and heavy rubber gloves are usually required for work with beta-active material and with radioactive liquids, dusts, or fumes that might contaminate the hands.

Protective clothing, such as coveralls or laboratory coats, shoes, shoe covers, and caps, should be provided. A few approved filter-type face masks should be available in

Fig. 4-4. Safety tongs cut down total body exposure to radiation by keeping radioactive sources away from the experimenter during chemical and transfer operations. They are especially important in protecting the experimenter's hands, which usually receive the most intense irradiation.

event of an emergency (such as a fire or chemical explosion) involving some radioactive material. A small room or a corner of one of the laboratories should be set aside for large trays and tubs used for the decontamination of equipment that cannot be cleaned in the usual manner in sinks. A space should be provided also for a household-type washing machine and dryer with which the contaminated clothing can be laundered.

Survey and Monitoring Instruments

Two types of radiation survey instruments—fixed and portable—are required. One of the desirable fixed instruments is a meter which sounds an alarm if the level of radiation exceeds a predetermined value. In the nuclear reactor building, the *neutron alarm meter* usually consists of a BF_3 counter surrounded by a few inches of paraffin; the output of the counter is fed into an amplifier and recorder and adjusted to sound an alarm when the neutron flux becomes excessive. The *beta-gamma alarm meter* consists of a Geiger counter or ionization chamber which is connected through an amplifier and recorder and set to alarm if the beta or gamma radiation-level exceeds the permissible value. A continuous *air monitor* should be provided in the nuclear-reactor building and in the "hot" chemistry laboratory. This consists of a filter paper and holder through which air is drawn at a constant rate, and a counter (alpha and/or beta plus alpha) that responds to the build-up of contamination on the filter paper. The output of this counter is applied through an amplifier to a recorder and an alarm system.

Two types of portable meters—area survey meters and personnel monitoring meters—are required. It is difficult to state exactly how many area survey meters are needed. As a general rule, at least two portable *area survey meters* are required to measure beta and gamma activity for each room in which work is being done with radioisotopes, or in which high-voltage accelerators or nuclear reactors are located. An alternate rule-of-thumb is to provide a portable beta plus gamma area survey meter for each two persons who are to work in an exposure area. These portable area survey meters should consist of Geiger counters or scintillation counters and one or more portable ion chambers. At least half of the meters should be furnished with output meters—rather than just head phones or loudspeakers—so that semi-quantitative survey data may be obtained. Some of the meters should be provided with sliding shields so that they can be used to discriminate between alpha, beta, and gamma radiations.

For work with alpha-emitting radioisotopes, two portable ion chambers or proportional counters should be provided for each room in which the work is done. Fig. 4-5 shows two common types of portable alpha survey meters.

The nuclear-reactor building should be provided with two portable *fast-neutron survey meters* and two *thermal-neutron survey meters*. The fast-neutron survey meters should be of the proportional-counter type shown in Fig. 4-6. One of the thermal-neutron meters might consist of a

Continued on page 1900

Electrolytic-Tinplate Instrumentation

By WILLIAM P. SMITH
Jones & Laughlin Steel Corp.

Each step on the electrolytic-tinplate production process uses instrumentation. Work remains to be done at several key points in the process.

ELECTROLYTIC TINPLATING is one of the newer continuous processes adopted by the steel industry to help conserve strategic material and to reduce the cost of tinplate products. Its development and acceptance were accelerated by the wartime shortage of tin and tinplate products. In the short span of ten years the electrolytic tinning line has become one of the most complex, yet one of the most versatile and efficient of the modern production techniques found in the steel mill. Lines have been built which integrate cleaning, pickling, tinning, and shearing processes into one vast unit which produces a continuous flow of tinplate. This article discusses the contribution of the control instrument engineer and suggests some lines for future improvements and developments.

Tinning Process

The tinning process begins with the raw material, consisting of cold-rolled strip which has been annealed and temper rolled, and which is furnished to the tin line in the form of coils weighing from 5 to 15 tons. The coils are uncoiled and fed into the line, where the ends are sheared square and the front end of each coil is welded to the tail end of the preceding coil to give a continuous band of steel throughout the line. Resistance-type seam welders are generally used, and electronic control of welding current is often a feature of these welders. There is a need for a better means of controlling weld quality because the integrity of the weld must be maintained throughout the balance of the line if costly operating delays are to be avoided. Resistance welding does not lend itself easily to control instrumentation because so many variables are involved—wheel pressure, weld-current magnitude and timing, and strip thickness and strip composition. However, the possibilities in this field have not been explored sufficiently.

Electrolytic Cleaner

After welding, the strip is propelled through the balance of the line at speeds up to 2000 feet per minute by a multiplicity of electric drives, first passing through an electrolytic cleaner in which the strip is immersed in a cleaning solution while a larger direct current of electricity is passed between the strip and an immersed electrode. The cleaning action depends mainly on the chemical action of the cleaning solution, aided by the agitation caused by gas formation at the surface of the strip as a result of electrolytic action. The three variables to be controlled in the cleaner are solution temperature, solution concentration, and the electric current. Temperature is controlled readily by a controlling potentiometer-type instrument with a thermocouple immersed in the solution. The controller operates a valve in the line supplying steam to heating coils inside the cleaner tank. The other two variables are interdependent and might lend themselves well to automatic control through manipulation of solution concentration and voltage of the electric source.

Pickling

After cleaning, the strip is scrubbed by a succession of revolving brushes and excess solution is wrung off. It then passes thru a sulphuric-acid pickle tank and another scrubber as final preparation for electroplating. The control problems in the pickling operation are similar to those in cleaning except that no electric current is involved. Solution temperature is controlled in the same manner and automatic control of acid concentration offers a possibility for future development.

Plating

The most important factors in successful tin electroplating are those involving the plating solution. The temperature and composition of the plating solution are of prime importance. As the rate of plating varies greatly at different line speeds and at different coating weights, the amount of heat evolved in plating is subject to wide variation. This makes it necessary to provide cooling as well as heating control in order to maintain solution temperature within the required range. The control must be accurate and fast, and must respond to small temperature variations. High-speed potentiometer-type indicating and recording controllers, working with thermocouples and motor-operated valves in steam and cold-water lines, have been applied successfully.

Little work has been done in the field of automatic *solution-composition control*. Analysis and pH are controlled by making periodic additions as dictated by the results of chemical tests. Such additions might be made automatically if suitable instruments were applied to measure important solution variables and total solution volume. Even if automatic control should prove unfeasible the continuous measurement and indication of solution variables would be valuable information that would permit closer control by periodic manual additions to the solution.

The second field for control instrumentation in the electroplating process is *control of plating thickness* or weight through control of plating current. Where the tin line is required to operate successfully at varying speeds, this control must vary plating current in proportion to line speed. Even if line speed does not vary, plating current must be regulated accurately to produce a uniform coating. In addition, the magnitude of current must be readily adjustable to permit rapid changes in coating weight as various orders come through the line. One of the most successful

Continued on page 1905

Presented at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

Significance of Air Temperature in

OPEN-HEARTH OPERATION

A velocity thermocouple proves to be an accurate and sensitive tool for diagnosing open-hearth-furnace behavior. Its use shows that air temperature has large influence on heat time.

by JOHN S. MARSH
Bethlehem Steel Company

PRINCIPAL function of the open hearth is to supply high-temperature heat in amount sufficient to make steel. For a given fuel, the only independent variable is air temperature; there is no known practical fuel capable of supplying an adequate fraction of high-temperature heat by burning it in air at atmospheric temperature. The main sources of improved performance through increased flame temperature are (1) use of combustion oxygen and (2) increased air temperature. Details of a study of the first item have been reported[1]; this article reports on the second. The first step was to devise a means of measuring air temperature.

Measuring Gas Temperature

Measurement of the temperature of a gas—such as air—is more difficult than that of a solid or liquid. A thermometer or thermocouple can be buried in the solid or immersed in the liquid with complete confidence; ordinarily either rapidly attains the temperature of the surrounding medium. In a gas, however, the measuring device is ordinarily heated by convection, but is disturbed by interchange of radiation with any container walls that it can see. If the walls are hotter or cooler than the gas, the measuring levice reads high or low because of extra heat received from or lost to the walls. The ordinary thermometer or thermocouple is unsuitable for measurement of gas temperature.

Many schemes have been proposed; no less than 26 were described by Mullikin[2]. One scheme is generally satisfactory. This consists of flowing the gas at high velocity over the thermocouple hot junction by means of an aspirator. The device is known variously as an aspirating pyrometer, a suction pyrometer, or a high-velocity thermocouple. In the form used by us, the thermocouple is protected from radiation by shields. Consequently, its precise description is multiple-shield, high-velocity thermocouple, hereafter abbreviated to *velocity couple* (Fig. 1). Although ceramic radiation shields are thermally suitable, they are too fragile. Nickel tubing proved most satisfactory, although its melting point is lower than is desirable.

It was necessary to determine the number of shields required; this was done by trying sets consisting of one, three, five, six, and seven concentric tubes. Nothing significant was gained by exceeding five shields.

Positioning of the couple with respect to intake point of the assembly was determined by withdrawing the couple until constant readings were obtained. This proved to be

Presented at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

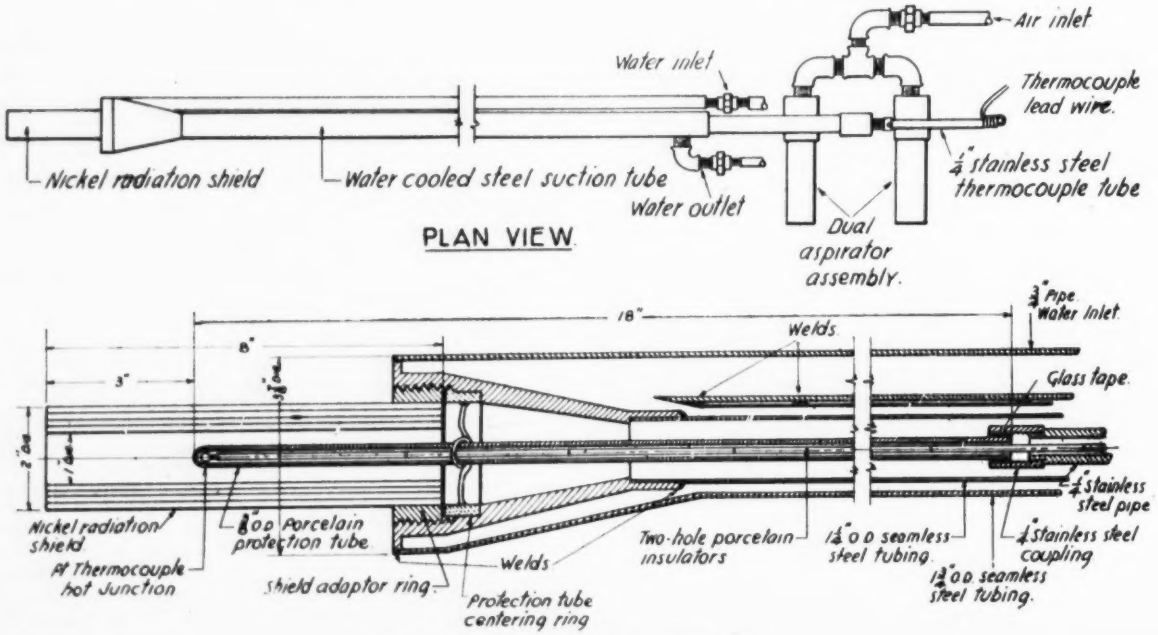


Fig. 1. The velocity couple, showing details of tip.

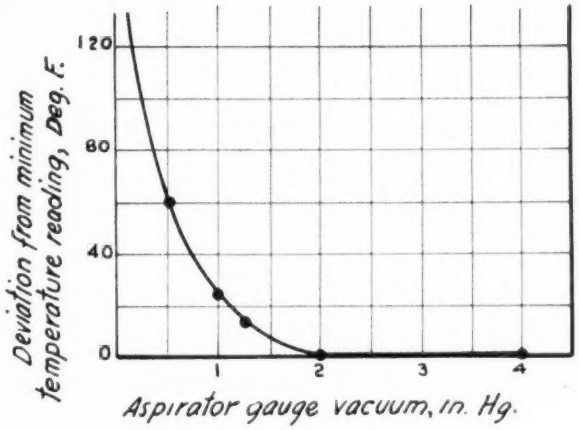


Fig. 2. Effect of gas velocity on velocity couple.

any point exceeding two inches from the intake; three inches from the intake point was adopted as standard. This is equivalent to a solid angle seen by the couple of 0.7 percent of the total radiating area.

The task remained of determining suitable gas velocity. This was done by operating the device at a series of gage vacua, as there is no simple way of measuring velocity. As the velocity produced by a gage vacuum of two inches of mercury is just sufficient (Fig. 2), operation of the aspirator to produce a vacuum of three inches was adopted; this is equivalent to a velocity of several hundred mph.

Accuracy

There is no primary standard of comparison for gas temperature. The results inspired confidence, yet there could be no certainty. However, it was possible to check the device against measurements obtained by the sodium-line-reversal method under actual open-hearth uptake conditions. (The spectral-line-reversal temperatures were measured by Mr. Keith Rumbel, of the M.I.T. Practice School, Lackawanna, N. Y.) These readings scattered about both

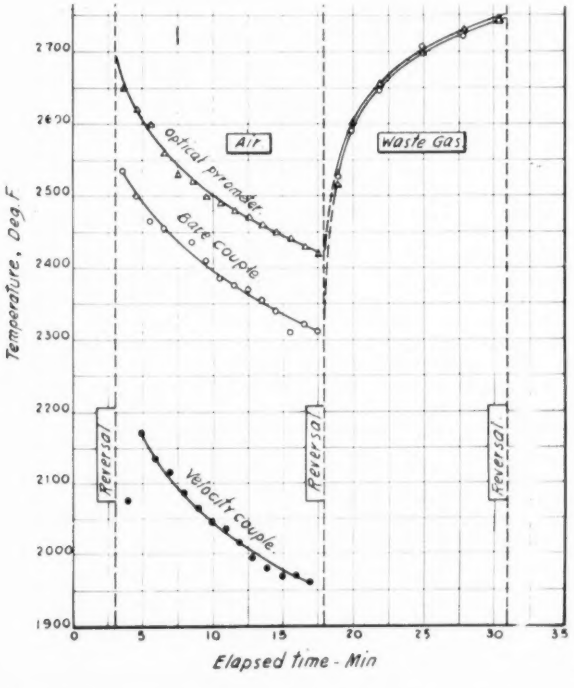


Fig. 3. A complete gas-flow cycle as measured with by optical pyrometer, bare thermocouple, and velocity couple. Large error of the first two instruments during the air-flow period is noteworthy.

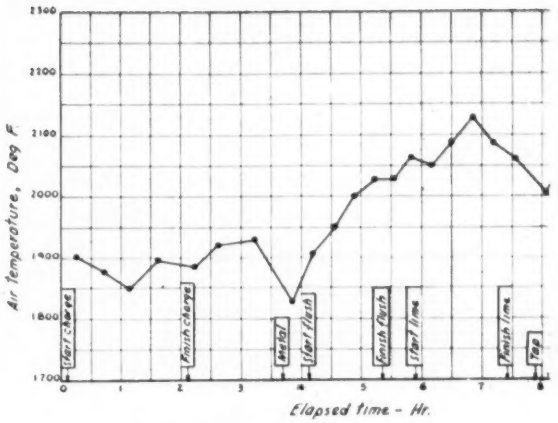


Fig. 4. Example of air-temperature plot.

sides of those taken simultaneously with the velocity couple in a way that suggests strongly that the velocity couple reads true gas temperature.

The device is not without limitations. The outermost nickel radiation shield can be warped or melted upon prolonged exposure to radiation from walls at temperatures exceeding about 2600 F., although susceptibility to such damage can be lessened by presence of oxide layer produced by exposure to lower temperature. The velocity couple is an instrument to be used by technicians. Several designs have produced some hundreds of individual measurements with no damage other than to protection tubes and shields.

Technique of Use

The velocity couple is used by insertion to about 40 inches through a hole in the uptake wall on the pit side, just above floor level. A transite sliding-fit shield blocks air leakage through that part of the hole not occupied by the device. Choice of location depends only on providing least interference with routine furnace operation. This does not mean that gas temperature is necessarily uniform over the cross section, although it is substantially so in a properly operated furnace.

Several sets of simultaneous readings by bare thermocouple, by optical pyrometer (sighted on the bridge wall or burner block), and by velocity couple were taken (Fig. 3).

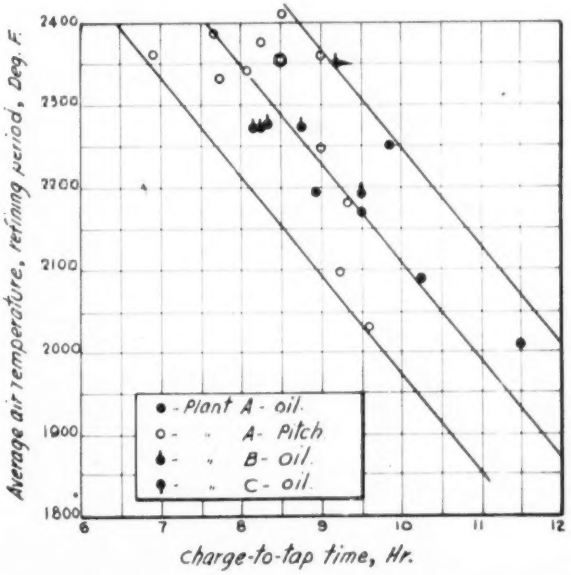


Fig. 5. Effect of air temperature on charge-to-tap time of 200-ton furnaces making low-carbon heats (under 0.06 to 0.20 percent carbon).

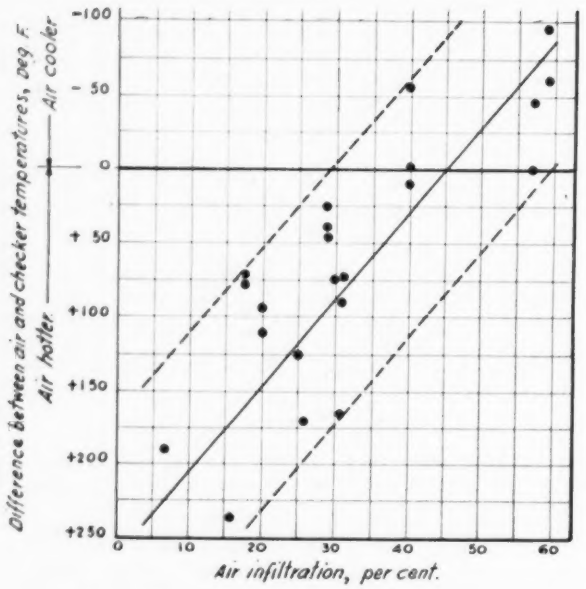


Fig. 6. Effect of air infiltration on air temperature.

The expected violent deviation from true air temperature exhibited by the bare thermocouple is shown; the couple comes closer to reading wall temperature. Unfortunately, there is no direct relationship between air temperature and wall temperature, hence there is no chance of applying a correction factor.

Matters are different for the waste-gas half cycle. Owing to the presence of carbon dioxide, water vapor, and suspended condensed particles, such gas radiates freely, and the unshielded thermocouple and optical pyrometer may be suitable measuring devices. The data in Fig. 3 are incomplete for the waste-gas half cycle by virtue of no velocity-couple readings. However, a few readings, obtained before the shields were destroyed by high temperature and slag, indicated that the optical pyrometer gives a reasonable approximation of waste-gas temperature.

As our interest was primarily in air temperature, for which the velocity couple is satisfactory, the practice was adopted of inserting the device only during air flow. Further, once measurement became routine, no effort was made to follow the first moments of air flow; Temperature drop is extremely rapid during this short period and has little influence on total heat input. Therefore, readings were taken at one-minute intervals with a portable potentiometer, or every half-minute with a high-speed potentiometer recorder.

Results

Data have been collected on air temperature for about 75 heats in about half as many furnaces in various shops. Information was gathered also in fuel and air flow, optical temperatures of uptake and checker walls, heat condition, air leakage, and so on. To simplify examination of data, air temperature at an elapsed time of five minutes from reversal was chosen arbitrarily as being most representative of the air-flow period. These values were plotted (Fig. 4).

It became increasingly clear that despite the many factors involved in determining the behavior of an open-hearth furnace, the influence of air temperature dominates. To provide a ready means of comparison, the average of the five-minute temperatures from the end of lime boil to tap was adopted. This was chosen because only during this period does air temperature reach a fairly steady level. A plot of such numbers against heat time (charge to tap) for 200-ton furnaces making low-carbon heats is shown in Fig. 5. Note that these furnaces are in three different plants. Considering the fact that "lucky melts" tend to move a given point to the left, and that errors of

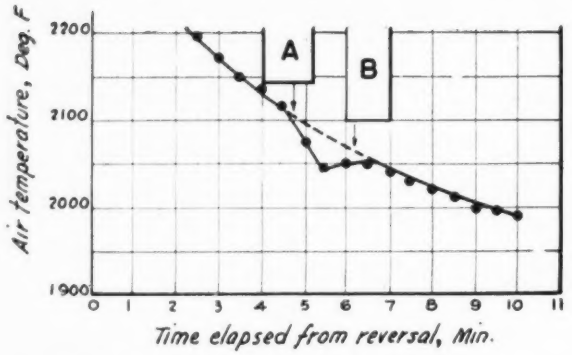


Fig. 7. Effect of opening a checker-chamber inspection door on air temperature.

judgement tend to move a given point to the right, the correlation is all the more satisfying. Each additional 100 F. of air preheat means, on the average, about 3/4 hr. shortened heat time. Similar behavior was found for smaller furnaces and for various fuels. The hotter the air the faster the heat.

Furnace performance is benefited by avoiding cooling as much as possible during the tap-to-charge period. Comparison of behavior during the charging and initial melting period with that during the refining period shows that full recovery from cold operation cannot be made in one heat. Thus, to maintain maximum productivity, a furnace must maintain its ability to preheat air.

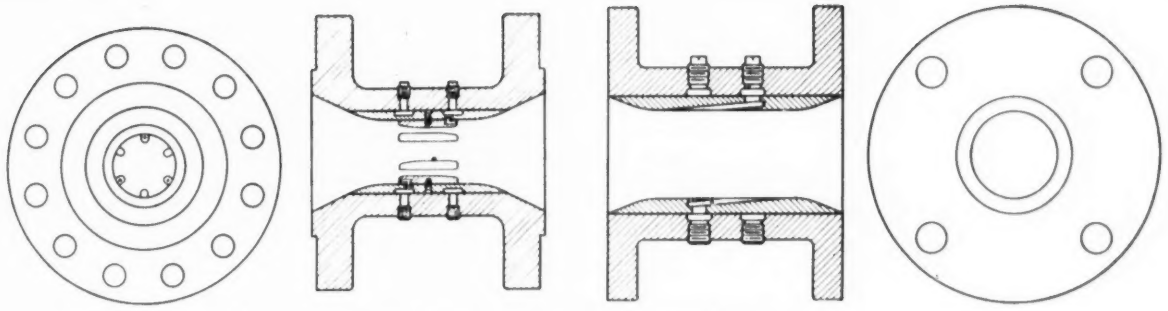
The most significant factor determining air temperature is temperature of the checkers. However, comparison of air temperatures with checker temperatures (determined by optical pyrometer) revealed air temperatures ranging from several hundred degrees cooler to several hundred degrees hotter than those of the checkers. This means that the regenerative system consists of more than the checkerwork—that fantails, slag pockets, and uptake walls are important. Air cooler than the checkers results from air leakage, or infiltration. In a low-leakage system, air continues to gain temperature during its passage through the regenerative system, but this gain can be completely offset by air leakage, and such leakage is increasingly damaging the later its point of entry. It may be deduced, then, that for a given furnace and fuel input, performance is governed principally by air leakage. This was tested by plotting infiltration (measured by oxygen analysis of simultaneous samples of waste gas taken from downtake and sewer) against temperature difference between air and checkers (Fig. 6). Although scattered over a band, there is a correlation.

During the study of the infiltration versus air temperature we became aware of the fact that the velocity couple is as informative to its user as is the clinical thermometer in the hands of a physician. For example, it is more reliable for measuring infiltration than are conventional methods. We have seen furnaces stay slow after passing the test of routine infiltration measurement. These furnaces invariably showed low air temperature. Upon reslurrying, increased air temperature and faster heats followed.

Such observations lead to several tests with deliberately introduced infiltration. In Fig. 7, for example, is shown the effect of opening an 8 x 12 in. inspection door in the hot-pass checker wall. Disturbance was violent enough to emphasize the undesirability of holes in the walls.

The result of one test of variation of primary air flow is given in Fig. 8. Increased air flow of 20 percent lowered air temperature about 60 F., enough to increase heat time about 1/2 hr. on the average. Proponents of large flow of excess air are evidently in difficult position. Of course, furnace pressure controls infiltration and hence air temperature; Fig. 9 shows the short-term effect of ore and hot-metal additions.

Continued on page 1908



Typical flow tubes. Left, "Model D"; right, "Model V."

FLOW TUBES

By E. W. RANDLE
Foster Engineering Company

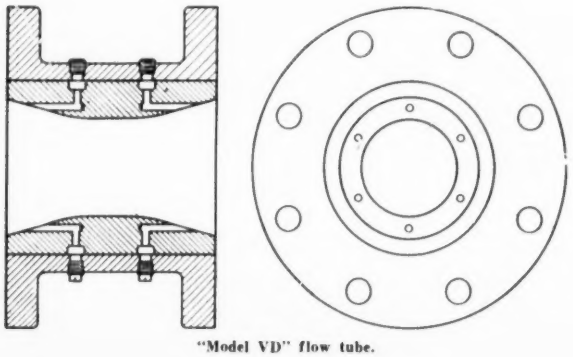
Flow tubes differ from orifices and Venturi tubes in using impact pressure, making possible high differentials with little throat contraction and reduced head loss.

FLOW TUBE is a head-type primary element for measuring the flow of fluids. It consists of a spool-shaped section, usually from one to two diameters in length. It has two groups of nozzles spaced around the inner periphery; one group points upstream, the other downstream. Those pointing upstream are connected through their piezometer ring to the high-pressure side of the meter; the latter are connected through the other ring to the low-pressure side.

Flow through the tube causes an impact pressure to be impressed on the nozzles pointing upstream, and a suction on those pointing downstream. The static pressure is essentially the same on both groups because they are located at points of equal cross section and velocity. Therefore, the differential is determined entirely by the throat velocity. On the other hand, orifices, nozzles, and Venturi tubes utilize the difference between the velocity head in the throat and that in the pipe; in other words, the velocity of approach is always an important factor in their coefficients. The flow tube differs from other metering elements also in that it utilizes the velocity near the throat wall, whereas the others utilize the mean velocity across the throat section.

Flow Tubes are made in three types—"Type D, Type V, and Type VD." There is also the modified "Type VDM."

Presented at Conference on Instrumentation In Water Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.



"Model VD" flow tube.

In the "Type D" two groups of streamlined nozzles are spaced around the throat. In the "Type V" the nozzles are eliminated, and the pressure ports are formed by drilling holes into the inner periphery at an acute angle. The high-pressure ports point upstream, and the low-pressure ports point downstream; the differential is produced by the viscous drag along the boundry layer. There is no direct impact. "Type VD" is a cross between "Types D and V." The ports are drilled parallel to the axis into the tapered sections on either side of the throat; the differential is produced by a combination of viscous drag and dynamic impact. "Type VDM" is another cross between "Types V and D," having the ports recessed in the cylindrical portion of the throat rather than in the tapered sections.

"Type D" is the one most widely used for low line velocities because it gives the maximum differential for a given ratio of contraction. "Type V" is for use with high line velocities. "Types VD and VDM" are used in small lines where "Type-D" nozzles would be too small to be practical.

Advantages of Flow Tubes

(1) It is symmetrical. As the front end is like the tail end, it measures flow in either direction. It cannot be installed backwards. Reverse flow causes reverse differential. This is important where it is necessary to measure the flow in both directions or where the metering element is used with control devices.

(2) As the Flow Tube uses impact pressures only, the contraction from main to throat can be made as small or as large as desired, depending on the velocity in the main. High velocities occur in penstocks, wind tunnels, jet fuel lines, etc. A Flow Tube can be installed with no contraction at all, and still provide differentials of 100 inches of water or more. With no contraction, conventional head meters would give zero differential. This characteristic makes it possible to design a tube with only enough contraction to produce a measurable differential. Head losses are thus minimized, with power savings in some installations amounting to several times the cost of the metering installation.

(3) As it utilizes impact pressure only, the Flow Tube can give a higher differential than a nozzle or Venturi tube for a given ratio. For small contractions it gives

Continued on page 1904

A Steel-Plate Thickness Meter

By S. S. CARLISLE and R. B. SIMS
British Iron & Steel Research Association

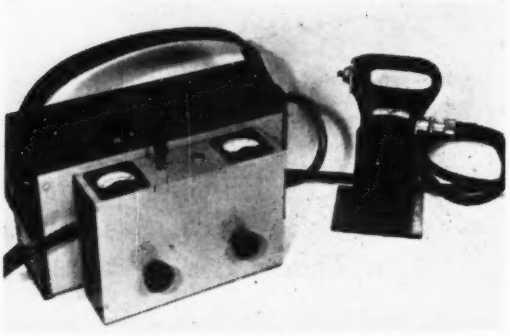


Fig. 1. Photograph of steel-plate thickness meter. Controls are on the left-hand unit; measuring head is shown on a sample steel plate.

An instrument for measurement of the thickness of steel plates when only one face is accessible uses the total magnetic induction in the body of the plate at saturation. Development, construction, and performance are presented.

THERE is a long-standing need for an instrument to measure the thickness of steel plates from one side only; for example, for determination of pipe wall thickness, for measurement of the wall thickness of tanks and ship hulls, and for gaging steel sheet in manufacture. The metal surface usually presented to the instrument is rough, pitted, and frequently coated with products of corrosion or several coatings of paint.

Several methods for measuring the thickness of sheet have been developed based on the determination of the *electrical resistance* between a pair of electrodes placed in contact with the surface and at a distance apart[1,2]. In some applications this method is satisfactory, but it entails measurement of small d-c. potentials, delicate measuring instruments, and good electrical contact between probes and surface.

Much attention has been given recently to *ultrasonic* methods for thickness measurement [3,4]. A continuously excited crystal transducer is applied to the surface of the plate. Owing to interference between the pressure wave transmitted and that internally reflected from the opposite face of the plate, a resonance occurs in the plate at particular frequencies, from which the thickness of the plate can be deduced. The resonance condition can be detected readily by measuring the power absorbed from the oscillator feeding the transducer.

This method is satisfactory only when conditions of both surfaces are reasonably good. Furthermore, the presence of paint or rust coatings reduces the ultrasonic power that can be fed into the plate and further increases the difficulty of detecting the resonance conditions.

Magnetic methods also have been devised for thickness measurement of ferro-magnetic materials. The usual technique is to make a portion of the plate complete a magnetic circuit with a laminated yoke carrying a magnetizing winding. The *magnetic reluctance* of the portion of the plate introduced in the magnetic circuit can be determined, and from this an estimate made of the plate thickness. Both a-c. and d-c. excitation have been employed[5,6]. The chief disadvantage of this method is that the measurement depends on the permeability of the material of the plate, which can vary according to its composition, magnetic history, and work hardening. With a-c. excitation, there is a limitation of the thickness that can be measured by the depth of penetration of the a-c. flux at the frequency used. The dependence on plate permeability is claimed to have been overcome in one instrument now marketed in the U.S.A. in which d-c. excitation is used, but the magnetic induction is increased to the saturation level.

Presented by J. V. Sturtevant, Pgh. Society for Quality Control, at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

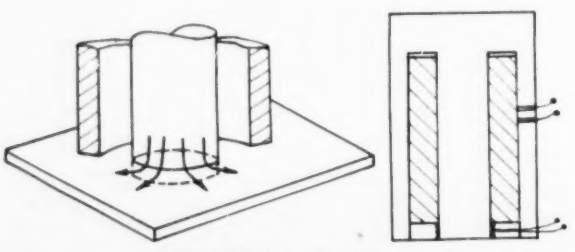


Fig 2. Electromagnet head.

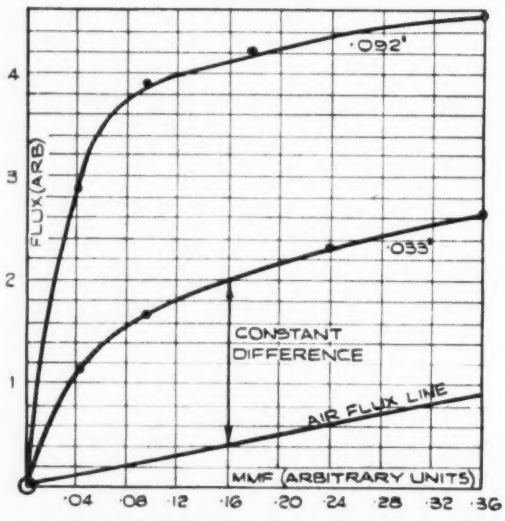


Fig. 3. Plot of flux vs. excitation for plates of different thickness.

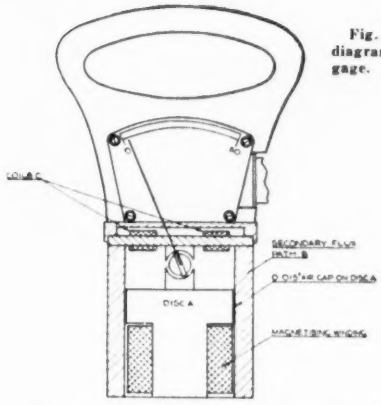


Fig. 4. Schematic diagram of thickness gage.

The instrument described in this article[9] also uses a magnetic saturation method but is considered to be superior to previously developed instruments in ease of use and the reduced effect of surfaces coatings on the instrument reading.

Use of Saturation Flux

Although the permeability of steels depends on the heat treatment and mechanical working, the value for the saturation flux density (B_{max}) is more precisely determined by the material composition alone. For example the B_{max} of ordinary carbon steels varies imperceptibly with heat treatment, and the effect of variation in carbon content is relatively small in the range of 0.1- to 0.5-percent carbon. At 1-percent carbon content the value for B_{max} is reduced by about 12 percent.

Heat treatment and mechanical working seriously affect the magnetic properties of high-alloy manganese steels, but low-alloy manganese, chrome, and copper steels have reasonably constant values for B_{max}.

For this reason it was decided that the method of thickness measurement based on the measurement of the total flux which can be passed through a section of the plate was a reasonable technique to employ for a wide range of carbon steels and low-alloy steels. Preliminary experiments to determine the sensitivity of the method were made using a pot-shaped electro-magnet measuring head shown in Fig. 2.

When this magnet is placed on the surface of a steel plate and the excitation increased, a stage is reached when saturation flux density (B_{max}) is set up in the surface of a cylindrical wall of the material immediately beneath the pot-magnet—provided, of course, the magnet pole does not become saturated first. As the area of the magnet core is πR^2, and the area of the cylindrical wall in the plate beneath the pole is $2\pi Rt$, where t is the thickness of the plate, it is necessary that R be appreciably greater than 2t to ensure that the pole does not become saturated. This assumes equal values of B_{max} for the material of the magnet and the plate.

Magnetization curves were drawn relating total flux in the electro-magnet with excitation current for a series of plates of different thickness (Fig. 3). A plot of flux vs. plate thickness at one particular excitation current demonstrated reasonably linear relationship over a range of plate

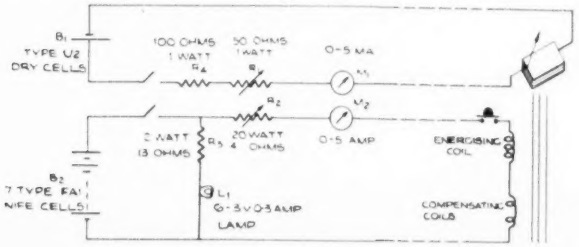


Fig. 5. Circuit details.

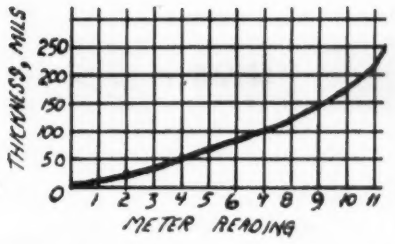


Fig. 6. Calibration curve.

thicknesses up to 0.08 inch for this particular measuring head. The results showed that the intervals between the magnetization curves for various plate thicknesses permitted reasonably accurate measurement of thickness. The results also suggested that an improvement would be obtained if the air flux (flux set up in the absence of plate) could be subtracted from the total magnetization.

The effect of heat treating samples of plates was investigated; no changes in the measured value of thickness could be detected on heating carbon steels to over 900 deg. C. and quenching in water.

In early experiments the magnetic induction in the pot-magnet system was measured by a search coil and ballistic galvanometer. This was unsuitable for industrial use and a number of alternative methods were considered including the use of bismuth-wire magnetic-field measuring elements and pivoted magnetometers[7,8]. These methods were rejected in favor of the technique now described.

B.I.S.R.A. Thickness Meter

The measuring head of the B.I.S.R.A. thickness meter is shown in Fig. 4. The moving-coil element is energized with a fixed current and is deflected against a control spring according to the flux traversing its air gap. The magnetic circuit of the moving-coil-meter movement is shunted across an air gap in the main magnetic circuit so that the flux traversing the moving-coil air gap is proportional to the flux in the main circuit, which is that set up in the sample of plate underneath the main magnet pole. By this means the angular deflection of the moving-coil meter is a direct measure of the magnetic flux in the main magnet circuit; the relationship between the meter deflection and the plate thickness can be controlled by variation of the moving-coil current. This permits adjustment of the instrument calibration to suit materials with radically different values of B_{max}.

One advantage of this shunt method of measurement of the main flux is that only a small magnetic reluctance is introduced in the main magnet circuit. This maintains the sharp bend in the magnetization curve obtained when the pot-magnet is placed on a sample plate, and also permits saturation of the section of the sample plate beneath the pole with reasonable values of magnetizing force. Sufficient magnetizing force is provided to ensure saturation of the thickest sections of steel plate which the instrument is designed to measure, despite paint or rust coatings on the surface up to 0.025-inch thick.

A further advantage is that the flux flowing in the main circuit in the absence of a sample of plate can be compensated by injecting into the secondary flux circuit a sufficient magnetomotive force to give zero deflection of the moving coil. If this magnetomotive force is provided by coils C, which are connected in series with the main excitation winding, the compensation will hold good over a wide range of excitation currents. Thus zero reading on the meter movement is maintained for variation of the excitation current with no test plate present.

When a plate is being measured the compensation for variation in excitation current is only effective over a limited range because of the change in the geometry of the magnetic circuit. The compensation is, however, sufficiently good to make it unnecessary for special precautions to be taken to stabilize the voltage supply in the instrument.

The effect of a non-magnetic gap between the plate surface and the measuring head has been studied. This effect is controlled primarily by the air leakage flux in relation

Continued on page 1903

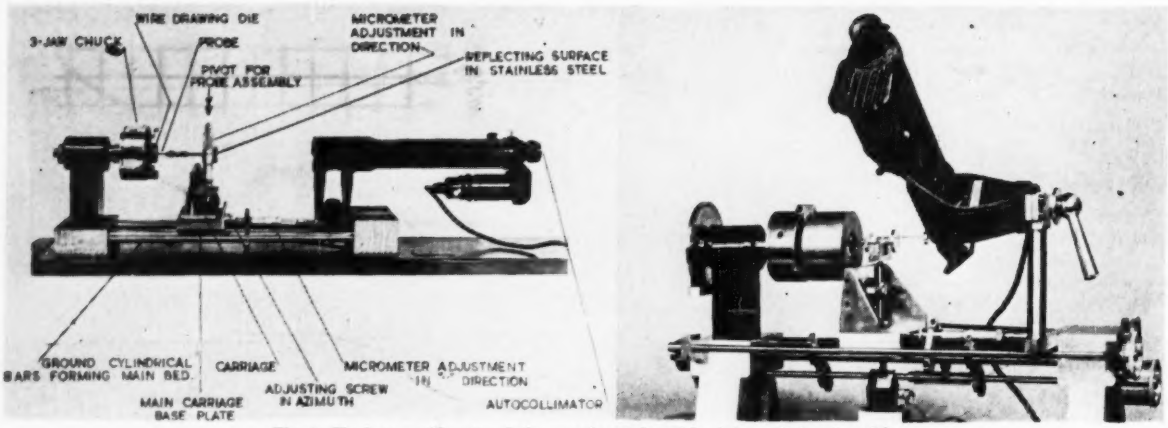


Fig. 1. The bore profilometer. Left, experimental model; right, redesigned model.

BORE PROFILOMETER

By S. S. CARLISLE and R. B. SIMS
British Iron & Steel Research Association

A profilometer for accurate measurements of the internal profile of small bores, as in wire-drawing dies, uses probe and optical-reflection technique. Development, features, and performance are presented.

SMALL BORES with diameters between 0.03 and 0.5 inch, with accurately shaped profiles, have become of great importance in recent years; wire-drawing-die bores and specially shaped nozzles are two examples. In checking the shape of these profiles, an accuracy of measurement of 0.0001 inch or better is often required.

Techniques of Inspection

Plug gages

Plug gages provide the simplest means of checking the diameters of bores which are known to be straight and of constant circular cross-section. However, if the bore is conical, or if there is a need to check the circularity, concentricity, or straightness, the plug gage is unsuitable.

Presented by J. V. Sturtevant, Pgh. Society for Quality Control, at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

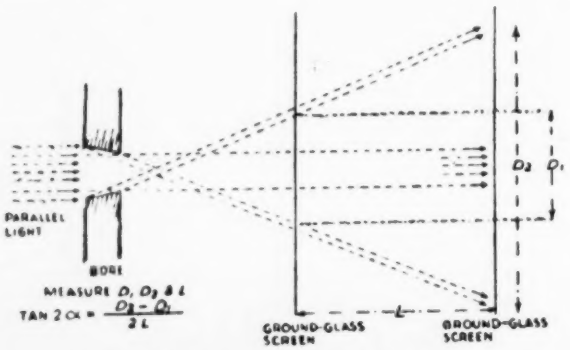


Fig. 2. Optical method for measuring die angle.

Replica Technique

The bore of a wire-drawing die has a rather complicated profile in which the entrance taper angle, the length of parallel section, the minimum diameter, departure from circularity, and the presence of small flaws such as "rings," are important characteristics. A low-melting-temperature alloy cast into the bore of the die has been found to provide a suitable replica technique for use in the wire-drawing industry. The resultant cast can be readily examined with a standard optical projector or micrometer[1]. A dental compound called "Zelex" has been found a satisfactory alloy for replica casting; using it the cone angle of the bore can be estimated to 5 percent, and the diameter to within 1 percent. Although of limited accuracy, the technique is superior

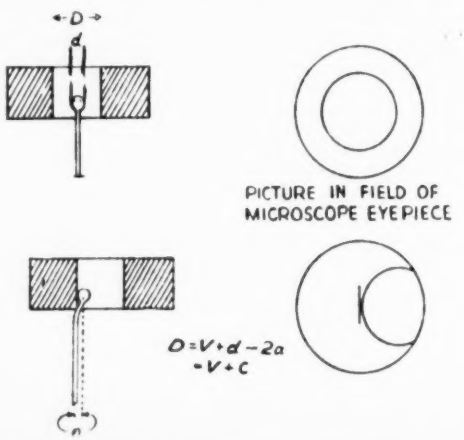


Fig. 3. Principle of Askania "Micro Bore Tester."

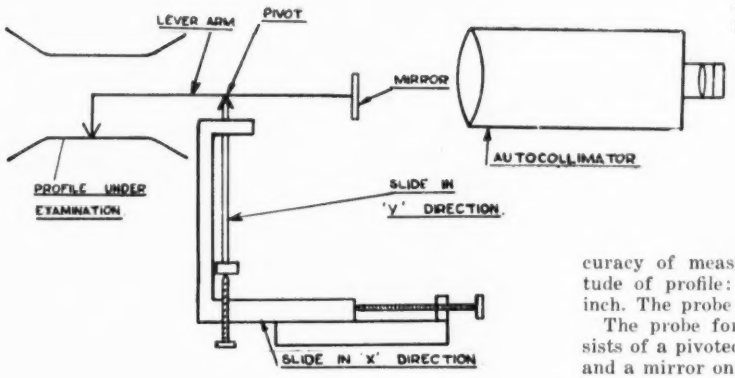


Fig. 4. Principle of the bore profilometer.

to earlier methods of simply studying the shape of a piece of partly drawn wire which has been extracted from the die bore.

Optical Projection

A number of optical-projection methods have been devised to measure particular characteristics of shaped bores; F. C. Elder[2] describes an optical method for measuring the cone angle of a taper section. Fig. 2 shows the method in which a parallel beam of light is projected into the bore, and the reflected rays are studied on a ground-glass screen placed at the other end of the bore.

The diameter of annulus D_2 thrown on the ground-glass screen is a measure of the cone angle. The measurement is best done by making observations of the diameter of the annulus for two positions of the ground-glass screen, as shown in the figure. An accuracy of 0.1 degree in the measurement of taper angle can be obtained for simple, straight tapered bores.

When there is appreciable rounding of the edge at the commencement of the taper, the definition of the illuminated annulus is reduced, with consequent loss in accuracy of measurement. The loss of accuracy with rounding is a particular disadvantage for inspection of wire-drawing die bores, which usually have a rounded entry to the taper.

Probe Technique

For more detailed and precise examination of bore profiles, a feeler or probe technique is required; these systems have shown themselves superior in all respects except simplicity of operation.

The Askania "Micro-Bore" tester (Fig. 3) employs a probe technique. The wire-drawing die whose bore is to be inspected is carried on the travelling stage of a microscope. A small bead on the end of a wire shank is situated in the bore so that the position of the bead in the bore can be studied through the microscope optical system.

Two models of this instrument are available, one for small bores not exceeding 11 mm. in depth and another for larger bores of up to 11 mm. in diameter and not exceeding 25 mm. in depth. The lower limit of diameter is 50 microns; the measuring accuracy is ±1.5 microns.

This instrument, however, cannot be used for the examination of blind or nearly blind holes because both sides of the bore must be accessible. Furthermore, a wide range of sizes of feeler probes is necessary to examine bores of large cone angles and of any appreciable depth. There are, however, many applications for this instrument in the study of parallel or small-angle taper sections, and a technique for making this instrument capable of automatic recording of bore profiles has been described in the literature[3].

A survey of available techniques showed that there still was a need for an instrument for precise measurement and recording of small bore profiles over wide ranges of diameter, bore length, and cone angle.

The B.I.S.R.A. Wire-drawing-die Profilometer

The specification to which the instrument has been designed is as follows: Bore diameter: 0.02 to 0.5 inch; accuracy of measurement: ±0.0001 inch; maximum amplitude of profile: 0.25 inch; maximum length of profile: 1 inch. The probe technique was used, as shown in Fig. 4.

The probe for inspection of the die bore (Fig. 5) consists of a pivoted lever arm with an enlarged tip on one end and a mirror on the other. If the probe-arm pivot is moved horizontally, moving the probe tip along the die bore, the mirror is tilted according to variations in the bore profile. An autocollimator is used to observe the angle of tilt of the probe-arm mirror, the angle of inclination of the mirror being re-set to some arbitrary value by adjusting the vertical height of the probe-arm pivot by the screw and slide.

The profile can be measured as follows: A micrometer screw is used to traverse the pivot assembly in the X direction; for each setting of the X micrometer the micrometer controlling the height of the pivot is adjusted to restore the mirror angle of inclination by observation with the autocollimator. The profile of the bore can be plotted from a table of corresponding readings of the X and Y micrometer screws. Fig. 6 shows a typical plot made with the first experimental model. In Fig. 6, the light line is the profile before use, the heavy line is the profile after 57,980 yards of wire have been drawn through the die. The minimum diameter increased from 0.2139 to 0.2159 inch. The magnification horizontally is 200x; vertically it is 20x.

The redesigned model is shown also in Fig. 1. The autocollimator has been turned through 90 degrees with the aid of a 45-degree mirror so that it can be used in a position convenient to the operator. The micrometer screws for control of the horizontal and vertical motion of the probe-arm system are brought out to control knobs on the right-hand side of the instrument. The X micrometer screw is situated so that it can be easily read by the operator; the Y micrometer screw, situated underneath the carriage assembly, can be read easily through an illuminated prism system.

To speed the measurement and plotting of bore profiles, a recorder has been developed. The recorder is mechanically coupled by flexible drives to the profilometer X and Y control knobs. The 6-inch-diameter drum is rotated according to the profilometer X motion (travel along the length of the die axis) and a recording pen is moved by a

Continued on page 1906

Fig. 5. The probe tip (magnified).

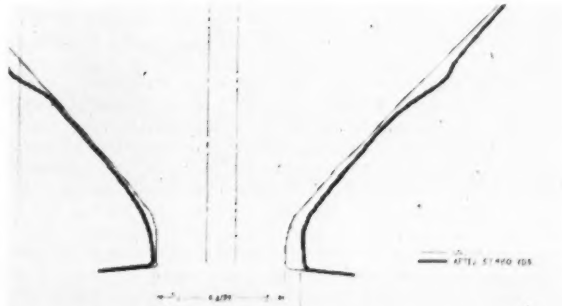


Fig. 6. Typical plot of wire-drawing-die profile.

Quality Control and Inspection

by W. L. YOUNG
Timken Roller Bearing Co.

Techniques by which the Timken Roller Bearing Co. maintains the precision tolerances of their tapered roller bearings illustrate the importance of statistical quality-control and complete instrumentation.

THIS is an age of high precision in industry. Whereas tolerances of thousandths of an inch were considered precise work 15 or 20 years ago, we now are confronted with tolerances of millionths of an inch. This advancement in precision is due to advancements made in (1) gages and measuring instruments, (2) machinery capable of producing parts of close tolerances, (3) proper control of the manufacturing processes, and (4) the various inspections required to produce the finished product.

For control of the manufacturing processes, The Timken Roller Bearing Company has adopted statistical quality-control, which is one of the most useful tools available to industry today. It is now possible to correctly establish machine capability and then to maintain that capability when the machine is put into the shop on production.

The Timken tapered roller bearing—one of the highest-precision products in the world—consists basically of a cup (or outer race), a cone (or inner race), a retaining cage, and a set of rollers. Variations of this combination of parts result in double- and four-row bearings such as those used in steel-mill and industrial applications.

The first step in the manufacture of the tapered roller bearing is *green machining*. Many different kinds of machines are used, ranging from multiple-spindle high-production machines used on the smaller automative-sized bearings, to large boring mills used to machine the large rolling-mill or industrial bearings.

Inspection of parts being produced on this operation consists of the use of statistical quality-control techniques employing special indicator-type gages developed by company engineers. Quality-control inspectors at the machines constantly check the process and plot the resulting measurements on average and range charts which are easily interpreted by the operator. This enables him to make machine adjustments before real trouble occurs.

The next step in manufacture is heat treating. Control of our carburizing process is based entirely on instrumentation. All furnaces have automatic temperature controls, most of which are the recording type.

As all bearing races are ground after hardening, *size control* is essential to obtain proper stock removal and clean up in grinding, but with no more stock than is necessary. Size control also is accomplished by use of statistical quality-control methods; the control inspector uses average and range charts. This information is of value not only for controlling the operation at the hardening machine, but also in analyzing it for proper expansion and contraction data, which sometime results in changes in the green dimensions of the product.

The many grinding processes on the component parts of the bearing are complex. As we have many finish-ground surfaces on bearing parts, there are many characteristics to control. Almost all of these characteristics are controlled by statistical methods utilizing average and range charts. If a point on the chart is found to go out of control, the operator is requested to shut down his machine immediately and make the necessary correction. If a machine repeatedly goes out of control, the assignable cause is searched out and corrected.

Some of the critical dimensions which are closely controlled are: cup and cone inside-diameter size, outside-diameter size, taper, surface finish, and out-of-roundness. For example, cone inside-diameter on one particular product is held from 0.0000 to plus 0.0005 inch. Surface finish on races in grinding operation are held to an average of 25 micro-inches. Honing, which is put on these surfaces after grinding, reduces the surface finish to under 8 micro-inches, as measured with a "Profilometer."

Our "Special Bearing Department" is devoted exclusively to custom-made bearings. Here, the Quality Control Inspector does not use as many statistical methods as are needed on routine jobs.

Our "Roller Grinding Department," where all rollers used in the Canton plant are finished, is one in which quality control has been an outstanding success. Since the adoption of statistical methods in 1949, we have reduced the rejections on this operation by 74 percent, and at the same time produce a roller which is superior in quality. This entire operation is set up on average and range charts for all important characteristics—taper, surface finish, out of roundness, etc. On certain grades we find it necessary to use electronic gages graduated to 0.00001 inch.

One might think that with the controls we have on the machines producing these parts, we could assemble the bearing as it comes from the finishing operations. That is not true. We have a finish inspection department for each of the component parts—cups, cone, and rollers—where these parts are 100-percent inspected.

We have been able to reduce our over-all rejection on prime product by more than 50 percent since applying statistical quality control to our manufacturing processes. The result has been higher productivity of prime product, as well as higher quality of finished product.

Life tests are run continuously in our Physical Laboratory in order to maintain and improve the performance of bearings. After physical testing, bearings are submitted for chemical and metallurgical analysis in our laboratories in search of properties which will improve quality further.

Of our total work force, one out of every four people is employed in maintaining quality standards.

Presented at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

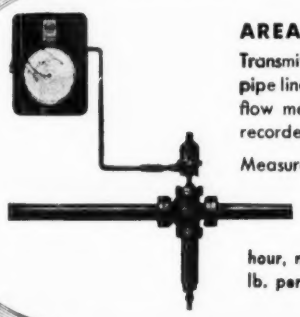
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials.



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 96,000 lb. per hour.

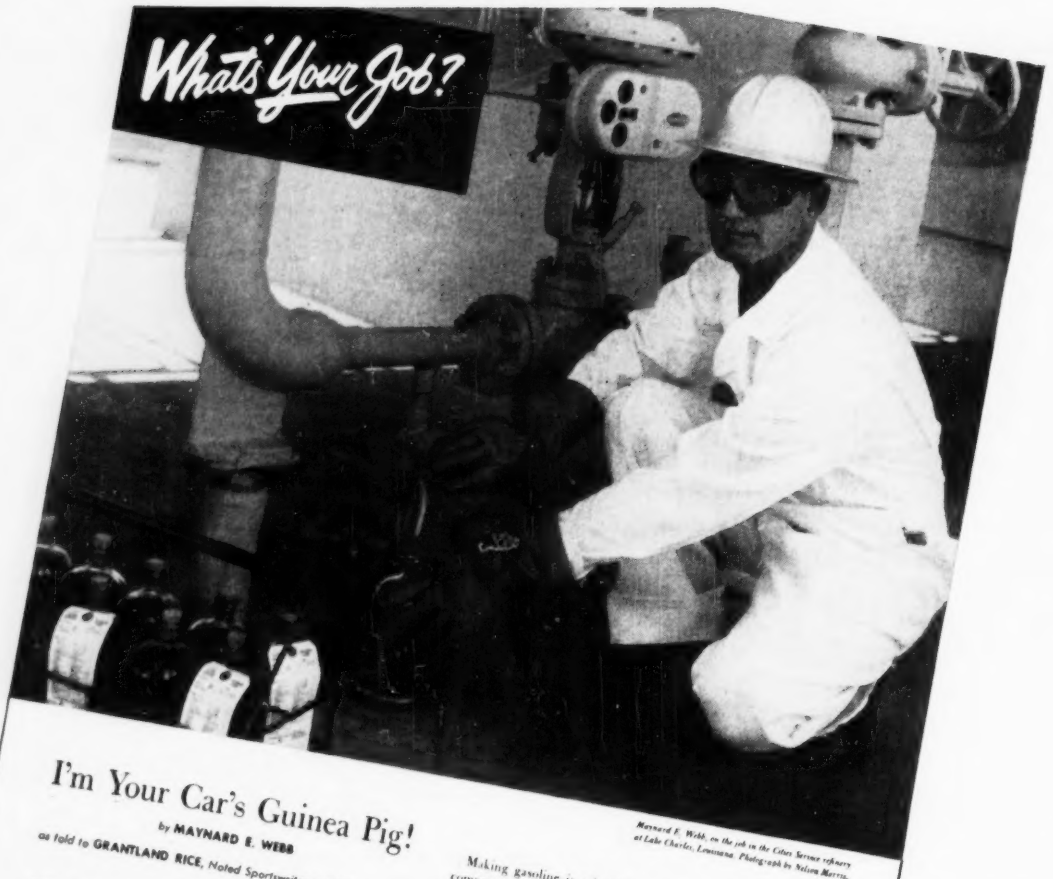
BAILEY METERS

BAILEY METER COMPANY

1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls · TEMPERATURE · · FLOW · PRESSURE · LEVEL · GAS ANALYSIS · RATIO

For more information circle **71** on inquiry card.



Maynard E. Webb, on the job in the Cities Service refinery at Lake Charles, Louisiana. Photograph by Nelson Morris.

I'm Your Car's Guinea Pig!

by MAYNARD E. WEBB

as told to GRANTLAND RICE, Noted Sportswriter and Commentator

THEY TRY OUT the gasoline ... If our reaction ...

... refinery pipe, we take a sample ... report our findings.

... every 15 minutes, test up to 20 different ways, and We couldn't be fussier if we were making baby food.

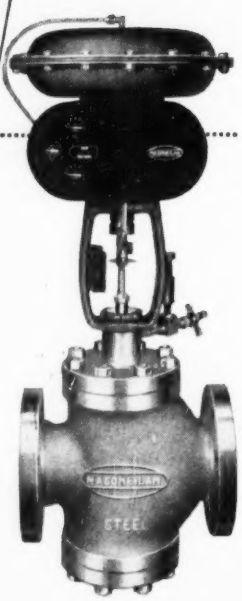
Making gasoline is a lot like making baby food, at the ... compression engine is as sensitive to ... formula. When a baby ... "sometimes ...

... care we take to turn out a fine gasoline. A book could be written on the subject. But I think you'll agree that we guinea pigs are probably the most important people in this refinery—from your car's point of view, that is.

CITIES SERVICE

Masoneilan 10000 Series Valve and 7000 Series Positioner at work in Cities Service refinery at Lake Charles, Louisiana

If your job is selecting Control Valves



get acquainted with the quality features which distinguish *Masoneilan* Control Valves. Learn about the built-in accuracy, stamina and economy which has induced thousands of quality-conscious companies like Cities Service, all over the world, to select Masoneilan valves as an important element in maintaining the quality of *their* products. Put Masoneilan Control Valves to work for you — helping maintain the quality of *your* product. Complete information on request.

Industrial Controls MASONEILAN *Specialists Since 1882*

MASON-NEILAN
REGULATOR CO.

1210 ADAMS STREET, BOSTON 24, MASS., U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco • Boise • Louisville Salt Lake City • El Paso • Albuquerque • Charlotte • Los Angeles • Corpus Christi • Denver • Appleton Birmingham • New Orleans • Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

For more information circle **72** on inquiry card.

INSTRUMENT SOCIETY of AMERICA Journal

National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pa., P. V. Jones, Jr., Society Manager.

Vol. 9 DECEMBER, 1953 No. 12

EXECUTIVE BOARD

President
PORTER HART

First Vice-President
D. M. BOYD, JR.

Vice-President
R. T. SHEEN

Vice-President
J. M. RIBBLE

Vice-President
WARREN H. BRAND

Secretary
W. A. WILDHACK

Treasurer
J. T. VOLLBRECHT

Past President
A. O. BECKMAN

CONTENTS

Sections Data 1888

ISA News 1889

Employment Service 1889

Applications of the Constant Temperature Hot-wire Anemometer to the Study of Transient Air Flow Phenomena 1890
By James C. Laurence and Gene Landes

Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday. Meeting 8:15 P. M.

ALBUQUERQUE
A. Richard Charlton, 1229 Girard Blvd. N. E., Albuquerque, New Mexico
Second Thursday, Meeting at 8:00 P. M.

ARUBA
M. A. Davidson, P. O. Box 452 c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I., 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
Roy W. Freeman, 27 Clarendon Ave., Avondale Estates, Ga.
Fourth Monday, Dinner Meeting 6:30 P. M ODK Banquet Hall, Georgia Tech.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapenke 6879
Second Friday, Meeting at 8:30 P. M.

BATON ROUGE
Thomas J. Folendore, 1540 Keed Avenue, Baton Rouge, La. Tel: 3-5567
First Monday, 7 P. M.

BLUE RIDGE
David C. Moore, Box 425B RFD #4, Roanoke, Va.

BOSTON
Joseph H. Bertram, 233 Harvard St., Brookline 46, Mass.
Fourth Wednesday, Dinner 6:30 P. M. Meeting 7:30 P. M. 99 Club, 99 State St., Boston
Jan. 27 "Relay Circuits for Control and Signal" by Enrico Klein, Chief Application Eng. Richardson Scale Co.

CALIFORNIA
Robert W. Fulwider, 5225 Wilshire Blvd., Los Angeles 36, Calif.
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

CAROLINA PIEDMONT
H. M. Messenger, 436 Sedgefield Rd., Charlotte, N. C.
Second Friday, Dinner at 7:30 P. M.. Meeting at 8:00 P. M. Cardinal Restaurant, Charlotte.

CENTRAL ILLINOIS
Eric B. Bensing, 1100 Hanssler Pl., Peoria, Ill.
Second Wednesday, 7:30 P. M.

CENTRAL INDIANA
Leon Stewart, Rock Island Refining Corp., P. O. Box 6091, Indianapolis, Ind. Tel: CO-2377.
First Tuesday, Dinner at 7:00 P. M. Business Meeting 8:00 P. M.

CENTRAL KEYSTONE
Frederick C. Belsak, 17 Hoffer St., Steelton, Pa.

CENTRAL NEW YORK
Fred Lingel, 712 Sumner Ave., Syracuse, N. Y.
Third Monday, Dinner at 6 P. M. Meeting at 8.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio. Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-way Grille, Rt. #2.

CHARLESTON
J. A. Rothwell, 310 24th St., Dunbar, W. Va.
First Monday, Dinner at 6:15 P. M., Meeting at 8:30 P. M., Kanawha Airport Terminal

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P. M. Builders Club, 228 N. LaSalle St., Chicago, Ill.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P. M.

CINCINNATI
Richard E. Surkamp, 7347 Richmond Avenue, Cincinnati 36, Ohio.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P. M., Engineering Soc. of Cinn.

CLEVELAND
R. C. Van Hala, c/o Van Hala Industrial Co., P. O. Box 2602, Lakewood 7, Ohio
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P. M. Battelle

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P. M.

EDMONTON
Ivan A. Windsor, 10931 Third Ave., Edmonton, Alberta, Canada.

DENVER
Lloyd Timblin, Jr., 935 Pleasant, Boulder, Colo. No regular scheduled meeting. U. of Denver, Science Bldg. Campus.

DETROIT
Philip Hill, Minn.-Honeywell Reg. Co., 13631 Plymouth, Detroit 27, Michigan
Third Wednesday, Meeting 8:00 P. M.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P. M., Siena College, Loudonville, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 109 S. Appleton St., Appleton, Wis.
First Tuesday, 8:00 P. M.

HOUSTON
A. Costa, 3507 Miliam St., Suite 204, Houston, Texas.
Last Monday 8 P. M. U. of Houston Library

KALAMAZOO VALLEY
John M. Perry, c/o Arthur B. Sonneborn Co., 1322 McKay Tower, Grand Rapids, Michigan.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M. Meeting at Red Arrow Legion Post.

KANSAS CITY
Donald D. Baker, 5823 Mission Rd., Mission, Kansas
First Tuesday, Meeting at 7:30 P. M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
W. L. Willoughby, 3508 Louisiana Ave., Lake Charles, La.
First Wednesday after last Monday in month. Columbia Southern Recreation Hall.

LOUISVILLE
O. Vern Spousta, 2000 S. Brook St., Louisville, Ky.
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MILWAUKEE
D. A. Spitz, Froefert Malting Co., 38th St. and W. Grant, Milwaukee 15, Wisconsin.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Tel. GI 5711
Last Monday of month, Meeting 8:00 P. M.

MUSCLE SHOALS
Frank W. Potter, T.V.A., Wilson Dam, Ala.
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Fourth Monday, Dinner at 6:00 P.M. Meeting at 8:00 P.M., N.Y.S. Technical Institute.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHEAST TENNESSEE
S. E. Abernathy, c/o Equinment Sales Corp., 341-345 W. Market St., Kingsport, Tenn.

NORTHERN CALIFORNIA
George W. Killian, 3718 Ramsey Court, El Sobrante, Calif. Tel: BEacon 4-0523
Third Monday, Meeting 8:00 P. M.

NORTHERN INDIANA
J. B. Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 8:00 P. M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
Thomas M. Gayle, 117 W. Vanderbilt Drive, Oak Ridge, Tenn. Tel: 2-1516.
First Wednesday Meeting at 7:30 P. M.

OGLETHORPE
R. A. Coffield, 2219 E. 39th St., Savannah, Ga.
Second Friday, 8 P. M. Reddy Kilowatt Room, Savannah Electric and Power Company.

PADUCAH
J. B. Russell, Carbide & Carbon Chemicals, P. O. Box 748, Paducah, Ky. Tel: 5-6311—Ext. 403
Second Tuesday Dinner at 6:30 P. M. Meeting 8 P. M.

PANHANDLE
R. L. Barnett, Box 1606, Amarillo, Texas
Third Tuesday, Dinner at 7:30 P.M. Phillips Grade School Cafeteria, Phillips, Texas

PERMIAN BASIN
Jack M. Ray, P.O. Box 1386, Odessa, Texas
Second Tuesday, Dinner at 8 P.M. Tel: 2-2813

PHILADELPHIA
A. S. Chatfield, c/o American Meter Company, 1513 Race St., Philadelphia 2, Pa.
Third Wednesday, Elks Club, 1320 Arch St., Dinner at 6:30 p. m., program at 7:30.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa. MA 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel

PRESQUE ISLE
F. L. Moore, American Meter Co., 920 Payne Ave., Erie, Pa.
Fourth Tuesday, Meeting at 8:00 P. M.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 10, New York. Tel: Hamilton 1468
Fourth Tuesday, Meeting 8 P.M. U. of R., Bausch & Lomb Physics Lecture Room 109.

SABINE-NECHES
R. A. Block, 2301 Avenue "G", Nederland, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Fourth Monday 8:00 P. M. YM-YWCA

SAVANNAH RIVER
F. D. Reed, 516 Goldman St., North Augusta, South Carolina
Second Wednesday, Dinner at 7:30 P.M. North Augusta Legion Post.

SEATTLE
Frank S. Melder, 2439 76th N.E. Bellevue, Washington, Second Friday.

SOUTH TEXAS
Homer C. Givens, P.O. Box 637, Falfurrias, Texas. Tel: 202
First Thursday, Engineers Club

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P. M.

TOLEDO
Warren G. Myers, 2257 Upton Ave., Toledo 6, Ohio.
Third Tuesday, 8:00 P. M. Edison Service Bldg. W. Delaware Ave., Toledo, O.

TORONTO
John W. Huether, 311 Sutherland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P. M.

TULLAHOMA
Owedia A. Montgomery, ARO, Inc., GDF Instrument Branch, AEDC, Tullahoma, Tenn. Tel: 636
Second Tuesday, Meeting at 7:30 P. M.

TULSA
G. R. McDannold, 1203 E. 130th St., Tulsa, Okla.
First Monday, Meeting at 7:30 P.M.

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P. M.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P. M.

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Michigan. Tel: Avenue 2-4178.
Third Monday, Meeting at 8:00 P. M.

WICHITA
J. W. Rieg, Koch Engineering Co., 123 S. Charles, Wichita 12, Kansas.
Third Thursday, 8 P. M. Scientific Bldg.

WILMINGTON
W. C. Ruglass, 900 A West 8th Street, Wilmington, Delaware.
Third Tuesday, "Hunt Room", Hotel Rodney, Wilmington, Delaware. Dinner 6:30—Meeting 8:00 P.M.

ISA NEWS

Fifth Pre-Instrument Maintenance Clinic Report

The Maintenance Clinic was an outstanding success this year judging from almost every aspect. Registration exceeded all expectations, the percentage of students completing the entire series was very high, the influence of the clinic was wide spread with registrations from all parts of this country and from foreign countries as well. A good cross section of industries, and of positions within those industries was represented, and perhaps most indicative of all—a large percentage of the students returned constructive comments, and their tone was very favorable.

Larsen

Lets take a look at some of the data we have collected about the clinic and the people who have attended.

Registration

444 registered before the first day of the clinic. (64 of these did not show up at the clinic.)

465 was the actual enrollment at the clinic, of whom about half were members of cooperating societies (184 belonged to ISA.)

119 persons of the 180 enrolled from Illinois were not members of ISA, and about 40 of those have since become members.

66% were instrument maintenance men, repair men, engineers, chemists, etc. 15% were foremen or supervisors. 3% were executives. 6% were sales personnel or sales engineers, and about 9% were others or not indicated.

69% of the enrollment was from non-instrument manufacturers distributed as follows:

- 17% manufacturing chemicals, adhesives, paint, plastics.
- 15% oil refining.
- 13% heavy manufacture such as automobiles, railroads, aircraft, trucks, farm equipment.
- 8% textile, rubber, glass, lumber and paper in-industries.

Response of Students

348 enrollees completed all eight class sessions to which they were assigned. This is just about 75% of those enrolled.

202 returned their cards with comments regarding the clinic. Those comments which referred to specific class sessions were evaluated and a rating of each class, as well as the entire clinic was obtained.

This information will be of considerable value to the 1954 Clinic Committee for planning their program next year.

Response of Sponsoring Companies

While no formal evaluation has yet been made of the response or recommendations of the companies who provided the lecturers and demonstration equipment, discussion with several of the lecturers brought out pretty general enthusiasm for the clinic. They seemed to feel that the questions and interest of the students pointed toward clinic as a very valuable customer relations service for the sponsoring companys.

EMPLOYMENT SERVICE

INSTRUMENTATION SPECIALISTS to be in charge of electronic instrumentation in connection with research and development of liquid propellants. Permanent salaried position with expanding group in the research department of a major chemical company located in the northeast. Requirements include: 2 years of college plus 3 years of experience or equivalent. Experience with electronic circuitry, highfrequency transient pressure measurement, and some knowledge of liquid propellants or chemistry desired. Send complete resume to Box 903.

SALES ENGINEER to handle full line automatic control requirements in process industries. Chicago Division. Engineering degree required. Factory and field training provided. All replies kept strictly confidential. Mail full particulars to Box 904.

SALES REPRESENTATIVE—Old established manufacturer of wide line of indicating and recording thermometers for laboratory and industrial use, requires sales representative for Buffalo area, to look after established business and develop new accounts. Advise fully, stating lines you are now handling and how much territory is being covered. Send particulars to Box 905.

ENGINEER or PHYSICIST for Instrumentation on experiment projects involving measurement of dynamic and transient phenomena. Good knowledge of theory of instruments and three years of instrument experience required. Some military work (U.S. citizens only). Mobility handicaps acceptable. Location—Texas. Box 906.

ELECTRICAL HEAT CONTROLS—Graduate in E. E. or M. E. for permanent position as project leader or design engineer in development of precision temperature controls. Must have at least five years experience in design of small mechanisms. New medium-size laboratory located near Pittsburgh. Send resume to Box 907.

PATENT ASSISTANT (B.S.,E.E.) — **CIRCUIT DESIGNER** (E.E.)—**TEST ENGINEER** (E.E.) —**PHYSICIST** (ION OPTICS)—**MECHANICAL DESIGNER**—**FIELD APPLICATION ENGINEER** (CHEMICAL) Whether a native Californian or interested in locating here, you can't go wrong checking these career positions now open. Our expansion of firm commercial business of building some of the world's finest scientific instruments can assure you of a secure future. If the positions above fit your interest and abilities, send full particulars to Box 908.

Announcement

Attention is called to the fact that this is the last issue of the ISA Journal to appear in *Instruments* Magazine.

Ever since the inception of the Society it was hoped and planned that some day the ISA would have its own independent publication. The growth of the Society and its activities in recent years has finally made a Society managed Journal a reality.

All members of the Society will receive this new publication starting in January 1954.

Current member's subscription to *Instruments* will continue until the expiration of their present annual membership. Therefore members will receive subscriptions to both *Instruments* and the new ISA Journal for varying periods dependent on expiration date of their membership.

Instruments Publishing Company has offered *Instruments* magazine to ISA members at a group subscription rate of $2.00 for domestic members. The National office will be pleased to cooperate by accepting and transmitting such subscriptions to *Instruments* for new and renewing members.

The Instrument Society of America appreciates the fine cooperation it has received throughout the years from Instruments Publishing Company and especially from its publisher, Richard Rimbach, who made it possible for the Society to have an avenue of communication for its membership.

Applications of the Constant Temperature Hot-Wire Anemometer to the Study of Transient Air Flow Phenomena

By JAMES C. LAURENCE*, and L. GENE LANDES*

Abstract. The constant temperature hot-wire anemometer uses a negative feedback voltage to provide continuous compensation for the lag in response of the hot-wire to fluctuations in air-flow. This system permits the study of flow fluctuations of unlimited magnitude and does not require knowledge of the time constant of the wire. Specific applications of the constant temperature hot-wire anemometer to be discussed in this paper include such periodic phenomena as vortex shedding from flame holders, compressor surge and rotating stall, and wake surveys of compressor and turbine blades; and, such nonperiodic phenomena as spectrum, intensity, and scale of turbulence, especially where ducting resonance and exhaust pulsations are present.

ONE of the methods of observing air flow fluctuations is to insert into the airstream a very fine electrically heated wire and to study the cooling effect of the airstream on the wire. In one technique, a constant electric current is passed through the wire and the fluctuations in wire temperature, as evidenced by fluctuations in wire resistance, are observed. In an alternate technique, an electronic servo system is used to maintain the wire at constant temperature by changing the current flowing in the wire, and the fluctuations in the current are observed.

In both of these techniques, it is necessary to consider the inability of the wire to follow air flow fluctuations because of the thermal inertia of the wire, and consequently, it is necessary to compensate for this thermal lag. To evaluate the relative merits of these two techniques it is desirable to examine first the basic equation of the hot-wire anemometer.

Basic Equation of Hot-Wire Anemometer

If a heated wire is placed in an airstream, it loses heat by convection, radiation, and conduction. King[1] was able to show, with certain assumptions, that the losses due to radiation and conduction are negligible and that the primary loss is due to convection. He derived a theoretical relationship,

$$\frac{\text{Power/unit length}}{\text{Temperature difference}} = \frac{i^2R}{T_w - T_a} = A + B\sqrt{\rho U} \qquad (1)$$

which shows that the rate of loss of heat is proportional to the temperature difference between the wire and the air stream and to the mass flow of air past the wire.

In this equation and in subsequent equations the following symbols are used:

A, B	constants
A'	area of wire exposed to stream
c	specific heat
D	diameter
e	instantaneous voltage
$\bar{e}$	average voltage
f	frequency
h	heat transfer coefficient
i	instantaneous current
K	anemometer calibration constant
L	scale of turbulence
m	mass of wire per unit length
Nu	Nusselt number
Pr	Prandtl number
r	$\overline{(e_i + e_f)^2}/\overline{(e_i - e_f)^2}$
$\mathbf{R}$	correlation coefficient
R	resistance of wire per unit length
Re	Reynolds number
T	temperature
u	x-component of velocity fluctuation
v	y-component of velocity fluctuation
w	z-component of velocity fluctuation
x, y, z	right-hand coordinate system with x in direction of the free stream
U	free stream velocity
ρ	density of air
κ	thermal conductivity of air
τ	time constant

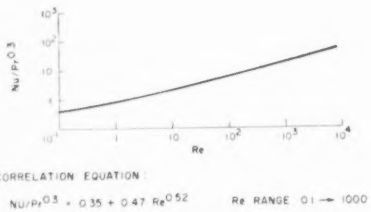


Fig. 1. Summary of heat-loss data from cylinders. (McAdams—Heat Transmission)

μ	coefficient of viscosity

Subscripts

o	no flow condition
a	ambient
f	frequency
p	constant pressure
x	longitudinal
y	lateral

Equation with Dimensionless Parameters

Equation *1* can be expressed somewhat more meaningfully, in terms of dimensionless parameters, as

$$Nu = \frac{1}{\pi} + \left(\frac{2}{\pi} Re\ Pr\right)^{0.5} \qquad (2)$$

where

$$Nu = \frac{hD}{\kappa}\ ;\ Re = \frac{\rho UD}{\mu}\ ;\ Pr = \frac{c_p \mu}{\kappa}$$

Here three dimensionless groups, which have been named Nusselt number, Reynolds number, and Prandtl number, are defined in terms of the heat transfer coefficient, the wire diameter, and the thermal conductivity, viscosity, specific heat, density, and velocity of the air.

Experimental results have validated an equation of this form and McAdams[2] summarizes the results of these experiments in the curve and the correlation equation shown in Fig. 1. More recent experiments have shown that the heat loss, as expressed by the Nusselt number, is a function of the Mach number and of the temperature difference between the wire and the airstream.

*Aeronautical Research Scientists, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland 11, Ohio.

The exact nature of this function is not known, but empirical relations have been determined which, together with standardized fabrication methods, make it possible to predict the heat loss from the wire with an accuracy of ±5 per cent. This reproducibility of hot-wire probes has reduced the calibration required to a single resistance measurement and has thereby increased the use of the hot-wire anemometer.

If the flow past the wire is fluctuating with time, the wire response lags behind the flow changes due to the finite heat capacity of the wire and the limited conductivity of the air which is stagnated around the wire.

Equation of Heat Equilibrium

The equilibrium existing at any moment among the rate of heat stored in the wire, the rate of convective heat loss to the airstream, and the rate of heat supplied to the wire by the electric current is represented by

$$mc\frac{dT}{dt} + hA'\,\Delta T = i^2R \qquad (3)$$

where

$mc\dfrac{dT}{dt}$ = rate of heat stored in wire

$hA'\,\Delta T$ = rate of convective heat loss

i^2R = rate of heat supplied to the wire

This equation can be rewritten as

$$\tau\frac{dT}{dt} + \Delta T = \frac{i^2R}{hA'}, \qquad (4)$$

where

$$\tau = \frac{mc}{hA'} = \frac{mc\ D}{A'\kappa} \times \frac{1}{Nu}$$

In this equation appears the quantity τ, the time constant, which is defined, as shown, in terms of the mass, the specific heat, the area of the wire exposed to the air stream, and the heat transfer coefficient. This expression for the time constant consists of two parts:

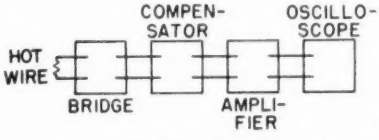


Fig. 2. Constant current hot-wire anemometer.

(1) A part which depends upon the physical properties of the wire.

(2) A part which depends upon the aerodynamic conditions under which the wire is operated.

Because of this time lag in response of the wire, it is necessary to compensate the hot-wire signal by some method in order to follow faithfully the airflow fluctuations. Compensation is usually accomplished by one of two general methods. One of these is the constant-current method and the other is the constant-temperature method.

Compensation by Constant-Current System

The constant-current system is illustrated by the block diagram in Fig. 2. It is called a constant-current system because the wire heating current is held constant during flow changes. The compensation is achieved by means of a passive network consisting of inductance and resistance, of capacitance and resistance, or of a transformer to provide a gain that is the mirror image of the response of the hot-wire, as shown in Fig. 3a.

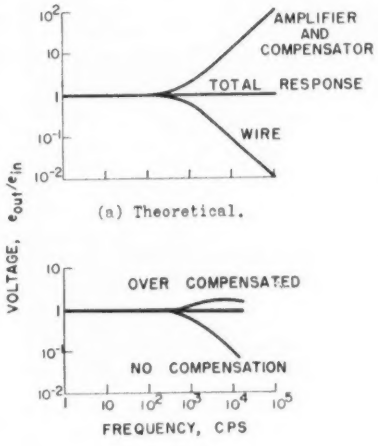


Fig. 3. Frequency response of a constant current hot-wire anemometer.

The result is a flat response of the complete system composed of amplifier, compensator, and hot wire, over the range of frequencies for which the compensation holds and for the particular flow conditions used for the setting. A change in flow conditions results in a new time constant and requires a new setting of the compensator.

The compensation required can be estimated and the network changed accordingly by injecting a square-wave signal across the wire and changing the network until a square-wave output is obtained. This method is difficult to use and in many cases it is more convenient to set the compensator so that the same output is obtained at two widely separated frequencies, say 50 cycles per second and 1,000 cycles per second, when a sine wave signal is injected across the wire. An example of a response curve of an NACA Lewis constant-current hot-wire anemometer is shown in Fig. 3b.

The constant current hot-wire anemometer has two limitations:

(1) The fluctuations must be small compared with the mean flow (less than 15 per cent of the free stream velocity)

(2) The magnitude of the time constant must be known in order to provide a suitable compensating network.

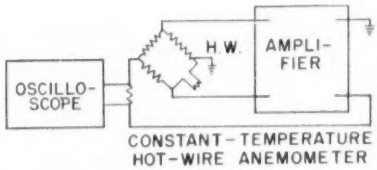


Fig. 4. Constant-temperature hot-wire anemometer.

The constant current hot-wire anemometer has been used in applications where the flow fluctuations are very small, and, in such applications, the frequency range has been necessarily limited in order to maintain a favorable signal-to-noise ratio.

Compensation by Constant-Temperature Method

The second general method of compensation for thermal lag in response of the wire is called the constant-temperature method and is illustrated in the block diagram of Fig. 4. In this case a negative feedback voltage provides the compensation, as shown in the diagram of Fig. 5a. The hot-wire bridge is energized by current from the amplifier and an unbalance signal is delivered to the amplifier. The amplifier produces an output current which is fed to the bridge with such magnitude as to restore the bal-

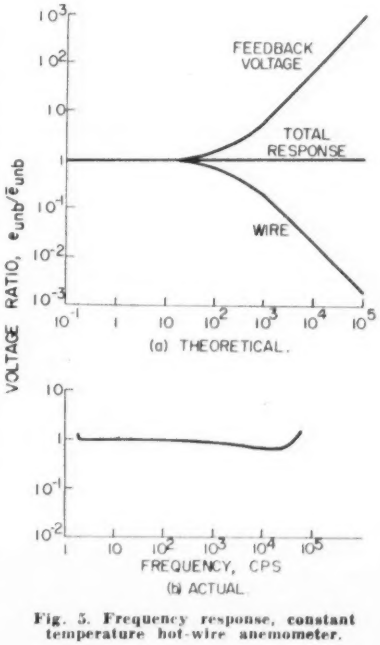


Fig. 5. Frequency response, constant temperature hot-wire anemometer.

ance of the bridge. The fluctuations in the current delivered to the bridge are a measure of the velocity fluctuations and are observed by means of the oscilloscope.

The constant-temperature hot-wire anemometer—so called because the wire is maintained at constant resistance (and hence constant temperature) by means of a Wheatstone bridge and the feedback voltage—has the advantage that continuous compensation is supplied for flow fluctuations with no limit to the magnitude of the flow changes and without knowledge of the time constant of the wire. A wide range of flow conditions resulting in a wide range of time constants does not affect the ability of the instrument to give a flat frequency response.

The constant temperature hot-wire anemometer at the Lewis Laboratory of the NACA follows the electronic design developed by Ossofsky[3] at this laboratory and uses a very stable direct coupled amplifier which has a frequency response flat from dc to 100 kilocycles. Many of the phenomena studied by means of the hot-wire anemometer (compressor and turbine blade wake surveys, vortices shed by flame holders, compressor surge and rotating stall, etc.) require a frequency response of 30,000-40,000 cycles per second or higher. The response curve of a constant temperature hot-wire anemometer (including a 0.0002-inch diameter, 0.080-inch long tungsten wire) is essentially flat from dc to 40,000 cycles per second, as is shown in Fig. 5b.

In the study of transient phenomena by means of the constant temperature hot-wire anemometer, the technique to be used can be selected by examination of the signal from the wire on the screen of the cathode ray oscilloscope. If the major components of the signal are periodic, the frequency of the components and the magnitude of the fluctuations are most often of interest. If the signal is non-periodic, the analysis is usually undertaken by means of the statistical theory of turbulence, of which more will be said later in this paper.

Study of Flow Past Flame Holders

Several examples of transient phenomena will be discussed and the techniques applicable to the study of each will be described. The first of the periodic flow phenomena to be described here is the determination of the frequency of vortex shedding by regular and irregular objects exposed to an air stream. In the study of proposed flame holder shapes, it was thought that the more turbulent the air stream at the rear of the holder, the better the mixing of the unburned fuels would take place. Thus it became necessary to study the flow past these flame holders.

The signal from the hot-wire was found to be very periodic—nearly a pure sine wave. In order to determine the frequency of the vortices being shed by the flame holder, the signal from the hot wire and the signal from a standard signal generator were placed on the oscilloscope, as shown in Fig. 6. By means of the Lissajous figures resulting, the frequency of the hot-wire signal could be determined.

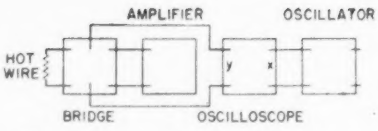


Fig. 6. Constant temperature hot-wire anemometer measurement of vortex shedding frequency.

Fig. 7 shows the measured frequency for a circular cylinder compared with the theoretical vortex shedding frequency calculated by means of an equation due to Lord Rayleigh[4]. In this figure, V_o is the stream approach velocity and V is that velocity corrected for the blockage of the duct by the cylinder.

Study of Rotating Stall and Surge in Compressors

A second application of the constant-temperature hot-wire anemometer is the study of rotating stall and surge in compressors. If, at a given speed of rotation of a compressor, the mass flow of air through the compressor is reduced sharply, one or more regions of stalled blades rotates with the compressor. As the mass flow is further reduced, the number of stall regions increases and finally surging results.

In these studies the frequency of the stall, the number of stall regions, and the magnitude of the velocity fluctuations are of interest. The hot wires are inserted in the compressor as shown in Fig. 8. The frequency can be determined in the same way as previously described for the vortex shedding problem. In order to determine the number of stall regions and their spacing relative to each other, use is made of more than one hot-wire anemometer. By using two wires in the same plane of the compressor, and by varying the angular separation between the probes, the investigator can determine the number of stall regions. The signals from two hot wires placed in a single stage axial flow compressor are shown in Fig. 9. The frequency of the signal as determined from the Lissajous figure is 77 cycles per second and analysis shows the presence of five stall regions separated by 72 degrees in the plane of rotation of the compressor.

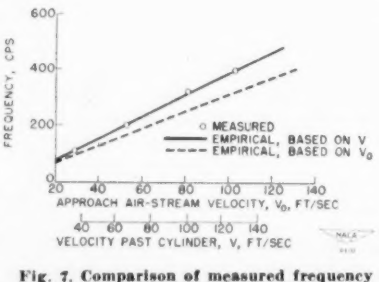


Fig. 7. Comparison of measured frequency of vortices shed by a circular cylinder with calculated frequencies using Rayleigh's equation.

Survey of Wakes

A third application of the periodic flow fluctuation technique is the survey of the wakes of compressor or of turbine blades to determine the velocity profile. An example of such a compressor is shown in Fig. 10. Also shown is the installation of the hot-wire probes to measure the velocity fluctuations. The magnitude of the mass flow changes is available from oscillograms such as are illustrated in Fig. 11.

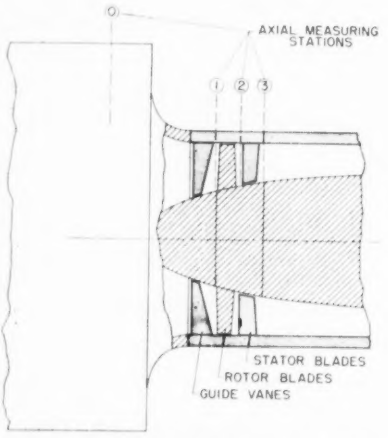


Fig. 8. Instrument stations in single-stage axial-flow compressor.

This oscillogram represents the mass flow profile across the passage of a 48-inch centrifugal compressor one-half inch beyond the impeller tip measured at a station 0.1 inch from the rear diffuser wall. Evaluation of the hot-wire data showed fluctuations varying from 1 to 8 per cent of the mean flow. By standardization of the probes such information is available without wire calibration to an accuracy of ±5 per cent.

Non-Periodic Flow Phenomena

In the previous discussion we have been considering periodic flow phenomena. For the non-periodic phenomena, the statistical theory of turbulence[5] is used as a basis for the analysis of the flow. Thus the intensity of turbulence is defined as the ratio of the root-mean-square value of the velocity fluctuations to the mean flow

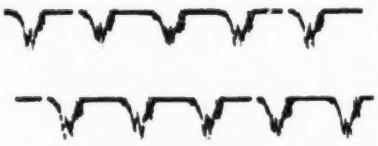


Fig. 9. Rotating stall in a single-stage axial-flow compressor.

velocity. If u, v, and w are the fluctuations in the x, y, and z directions respectively, with the x direction in the direction of the mean flow, the three different intensities are given by

$$\frac{\sqrt{(\overline{u^2})}}{U} \qquad \frac{\sqrt{(\overline{v^2})}}{U} \qquad \frac{\sqrt{(\overline{w^2})}}{U} \qquad \text{Intensity of turbulence} \qquad (5)$$

In the particular type of turbulence called *isotropic* these three intensities are equal to each other.

The relationship between the velocity fluctuations at two different points in the stream is represented by quantities called the *correlation coefficients* whose definitions are

$$R_x = \frac{\overline{u_{x,1}\, u_{x,2}}}{\sqrt{(\overline{u^2_{x,1}})}\ \ (\sqrt{(\overline{u^2_{x,2}})}}$$

$$R_y = \frac{\overline{u_{y,1}\, u_{y,2}}}{\sqrt{(\overline{u^2_{y,1}})}\ \ \sqrt{(\overline{u^2_{y,2}})}} \qquad \text{Correlation coefficients} \qquad (6)$$

$$R_t = \frac{\overline{u_o\, u_t}}{\sqrt{(\overline{u^2_o})}\ \ \sqrt{(\overline{u^2_t})}}$$

The correlation coefficients are measures of the velocity fluctuations of the turbulence—the relationship with respect to distance is represented by the quantities R_x and R_y; the relationship with respect to time is represented by the quantity R_t. The scale of turbulence is defined as

$$L_x = \int_o^x R_x dx \qquad \text{—Eulerian longitudinal scale}$$

$$L_y = \int_o^x R_y dy \qquad \text{Eulerian lateral scale} \qquad (7)$$

$$L_t = \sqrt{\overline{u^2}} \int_o^x R_t dt \qquad \text{—Lagrangian scale}$$

Its physical meaning can be described as an average size of the eddies present in the flow.

The hot-wire anemometer has proved to be the most powerful tool in measurements of intensity and scale of turbulence. The measurements reported to the present time have been made with constant-current equipment but measurements have also been made with constant-temperature apparatus and the techniques developed will be described in detail.

Measuring Intensity of Turbulence

In the measurements of intensity of turbulence the anemometer is used with supplementary equipment as indicated in Fig. 12. The hot-wire signal (bridge unbalance) is led directly to an electronic instrument called the *average square computer*. This instrument utilizes an electronic circuit to give a meter reading which is directly proportional to the average square of the input voltage and which operates regardless of wave form within its frequency limits.

A modified block diagram of this computer is shown in Fig. 13. It has been shown for some vacuum tubes having effectively co-planar control grids, that there is a change of direct current component of plate current proportional to the product of the control-grid voltages and the cosine of their phase angle.

By the use of two tubes with their plate circuits connected in push-pull, the static dc component may be balanced out. A-c components of the plate current are of no concern since a d-c meter is used in the output. If the two control-grid voltages are in phase for both tubes, the dc component of plate current will be cancelled out. Therefore, these grid voltages are fed 180 degrees out of phase for one of the tubes. The squared output is then merely twice the value for one tube.

The reading of the average square computer is combined with certain constants in the equation

$$\frac{\sqrt{(\overline{\Delta\rho U)^2}}}{\overline{\rho U}} = \frac{4K}{\left[1 - \left(\frac{e_o}{e}\right)^2\right]} \cdot \frac{\sqrt{\overline{\Delta e^2}}}{\overline{e}} \qquad (8)$$

to obtain the intensity of turbulence.

Obtaining Turbulence Spectrum

If the intensities are measured at different frequencies and if they are plotted against the frequency, a turbulence spectrum results. These measurements are made most readily with a hot-wire anemometer and appropriate electronic filters. If a spectrum is desired for discrete frequencies, the anemometer is used with a variable frequency band pass wave analyzer. The apparatus is connected as shown in Fig. 14a.

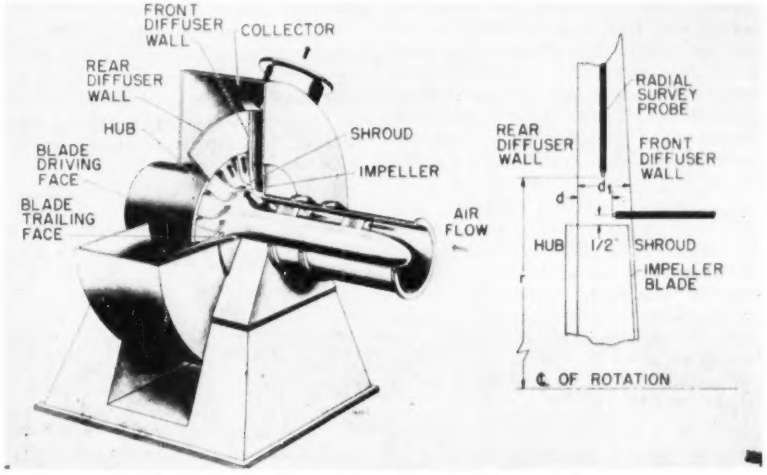


Fig. 10. 18-inch impeller test rig showing hot-wire installation.

The relation between intensity and frequency is given by

$$\frac{\overline{u_f^2}}{\overline{u^2_{total}}} = \frac{\frac{4L_x}{U}}{1 + \left(\frac{2\pi L_x}{U}\right)^2 f^2} \qquad (9)$$

where u_f^2 is the energy per unit frequency interval and u^2_{total} is the total energy in the turbulence spectrum.

An example of such a spectrum induced by screens in a wind tunnel is given in Fig. 14b. The theoretical curves are calculated by the use of equations given by Dryden, and illustrate scales of turbulence of 0.1 and 0.2 inch respectively. The peaks in the measured curve (occurring at frequencies of approximately 25, 800, and 2400 cycles per second) represent periodic fluctuations in the compressors and resonance in the duct.

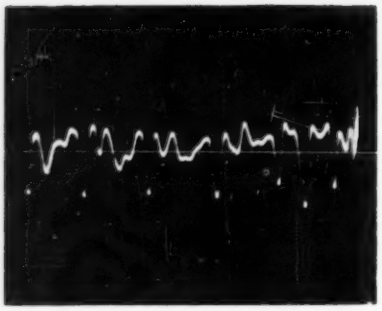
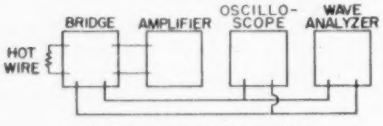


Fig. 11. Velocity profile. 48-inch centrifugal compressor.

Scale Measurements

The longitudinal scale can be obtained from the spectrum measurements and this method proves to be one of the best methods of making such measurements. Since empirical relations exist among the three scales defined previously, it is possible to obtain the complete scale measurement by spectrum analysis and a single wire.

In some experiments, however, it is desirable to make scale measurements by means of the correlation coefficients. Since we are concerned with measuring the relationship between the velocity fluctuations at two points, a double wire probe, either in a parallel wire array or in an X-wire array[8], is used with two hot-wire amplifiers as is shown in Fig. 15.



(a) Apparatus connections.

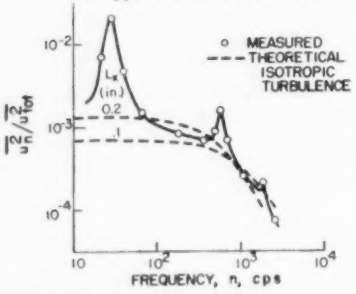


Fig. 14. Spectrum measurement, discrete-energy spectrum method.

In conjunction with the two hot-wire anemometers and a parallel wire probe, a "double correlation computer" is used. This instrument gives a meter reading which indicates the ratio of the average square of the sums and differences of the outputs of two hot wires. Since the average square computer does a part of this operation, a circuit is required to take the sums and differences and the ratio of the sums and differences.

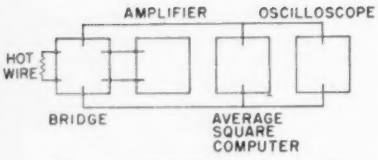


Fig. 12. Measurement of intensity of turbulence.

A modified block diagram of this computer in Fig. 16 shows that the adding circuit is a twin triode type of mixing circuit with calibrating potentiometers at the inputs. The difference circuit utilizes the same principle except one of the inputs must have its phase inverted. This inversion is accomplished by a triode amplifier operating with nearly 100 per cent negative feedback.

When all four circuits are adjusted to have the same gain, the calibration is complete. A direct current ratio meter is used to measure the ratio of the outputs from the average square computers. This meter reading can be used with the equations:

$$R_p \propto \frac{\overline{(e_1 - e_2)^2} - \overline{(e_1 + e_2)^2}}{\overline{(e_1 - e_2)^2} + \overline{(e_1 + e_2)^2}} \qquad (10)$$

$$R_p \propto \frac{1 - r}{1 + r} \qquad (11)$$

where

$$r = \frac{\overline{(e_1 + e_2)^2}}{\overline{(e_1 - e_2)^2}},$$

to calculate the lateral correlation coefficient and from that the lateral scale.

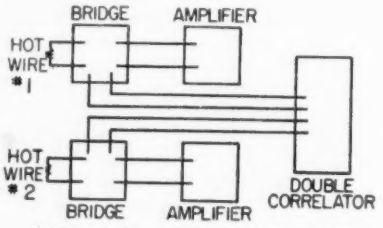


Fig. 15. Measurement of correlation coefficient.

If the magnitude of the scale, as measured, is of the same order of magnitude as the length of the hot wire or is less than the length of the hot wire, corrections must be made for the effect of the length of the wire on the scale measurements. In the measurements reported here the scale measured is several times the length of the wire and no corrections are necessary.

Conclusions

In conclusion it has been shown that:

(1) The constant-temperature hot-wire anemometer has been used in the study of flow fluctuations associated with jet engine research because of its inherent advantages. These are: continuous compensation, no limitation as to the magnitude of flow changes, and no knowledge required of the value of the time constant.

(2) Since the input signals encountered are large compared to the input noise level of the constant temperature hot-wire anemometer, it is possible to attain flat response over a very large frequency range.

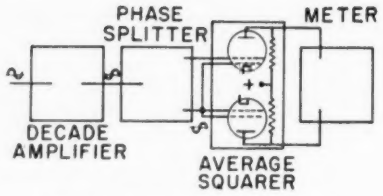


Fig. 13. Average square computer.

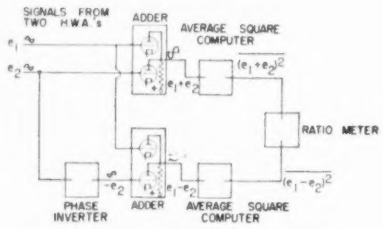


Fig. 16. Double correlation computer.

References

1. King, Louis V.: "On the Convection of Heat from Small Cylinders in a Stream of Fluid, with Applications to Hot-Wire Anemometry." *Phil. Trans. Roy. Soc.* (London), **214**, 14, Ser. A, pp. 373-432 (1914).

2. McAdams, Wm. H.: "Heat Transmission." McGraw-Hill Book Co., Inc., 2nd edition, pp. 210-230, 237-246 (1942).

3. Ossofsky, Eli.: "Constant Temperature Operation of the Hot-Wire Anemometer at High Frequency." *Rev. Sci. Instru.*, 19, 12, p. 881-889, (1948).

4. Rayleigh, Lord: "Aeolian Tones." *Phil. Mag. and Jour. Sci.*, 29, Ser. 6, pp. 433-444, (1915).

5. Taylor, Geoffrey I.: "Statistical Theory of Turbulence. Parts I-IV." *Proc. Roy. Soc.* (London), **151, 873**, Ser. A., pp. 421-478, Sept. 2, 1935.

6. Schubauer, G. B. and Klebanoff, P. S.: "Theory and Application of Hot-Wire Instruments in the Investigation of Turbulent Boundary Layers." NACA Wartime Report W-86. Mar. 1946.

JOURNAL of the
Southern California Meter Association

President: James A. Serey, Jr.
Vice-President: Glen C. Wilson
Secretary-Treasurer: George H. Forster, Jr., 640 Fillmore St., Fillmore, Calif.
Auditor: Philip Ver Planck, Jr.
Past President: F. M. Partridge

Installation and Maintenance of

ORIFICE METERS

Proper installation, inspection, and maintenance of orifice fittings, regulators, and differential gages are necessary for accurate measurements. Maintenance details are presented.

By W. D. STRAIGHT
Southern California Gas Co.

ORIFICE-METER installation consists of (1) the tube run, (2) the orifice fitting and orifice plate, and (3) the differential gauge; a regulator may be added on the inlet or outlet of the meter set depending on the conditions under which the meter operates.

Tube Runs

The tube run consists of two units—the upstream (or inlet) unit and the downstream (or outlet) unit. These tubes are bored to predetermined tolerances set up by recognized authorities on measurement of gas and liquids. The inlet tube generally contains straightening vanes to reduce the turbulance of liquids or gases before they reach the orifice plate. The inlet tube may also contain a thermometer well, a sample tap, and a drain tap. However, in field measurement from wells, the thermometer tap and sample tap generally are found on the outlet tube.

The downstream tube, the shorter of the two sections, provides unrestricted flow away from the orifice.

Orifice Fitting

The orifice fitting, or flange, is located between the two sections of tubes. Its purpose is to hold the orifice plate perfectly centered in the tube run, and to facilitate ready access to the orifice plate for cleaning or changing.

There are two types of orifice fittings —the *senior fitting* and the *junior fitting*. The senior fitting has two chambers separated by a sliding or plug valve. By raising the plate into the upper chamber and closing the valve between the two chambers, the operator is able to inspect or change the plate without shutting off the flow of liquid or gas in the tube. The junior fitting does not have the upper chamber, making it necessary to remove the pressure from the tube before removing the orifice plate. With the junior fitting it is necessary to have a by-pass around the tube run.

Differential Gauge

The differential gauge is the recording or indicating unit. It consists of two parts—one to measure the difference in pressure between the upstream and downstream side of the orifice plate, and the other to measure the static or line pressure at the downstream side of the orifice plate.

The differential part consists of two cast-iron chambers connected by a "U" tube. These chambers are filled to a predetermined level with mercury. A float in one of the chambers rests on top of the mercury. From this float an arm extends to a shaft that rotates with the rise and fall of the mercury. The shaft extends through the cast-iron body through a stuffing box which seals the pressure within the chamber. The pen arm is fastened on the other end of the shaft.

As the rise and fall of the mercury is measured in only one of the chambers, the ratio of the diameters of the two chambers must be constant. This condition makes it necessary that the inside diameter of these pots be true throughout their complete measuring range.

Regulator

A regulator may be used, depending on the conditions under which the gas is to be measured. Some of the problems to be considered in selecting the proper regulator are the size of the load, the load characteristics, the stability of the inlet pressure, the pressure differential across the regulator, and what type of loading system is most applicable to the situation.

There are two basic types of regulators in general use—(1) the single valve and (2) the balanced-valve, or double-valve, type. The single-valve regulator generally is used when the inlet pressure is fairly constant and the pressure differential is small. The balanced-valve regulator is more adaptable to varying conditions; extreme differentials in pressure between the inlet and outlet may be used without affecting the regulated pressure. Also,

January Meeting: Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.

Feature: to be announced.

a much wider range in loads can be handled through the balanced-valve regulator.

The type of diaphram loading also depends on load characteristics. The single-valve regulator usually is spring loaded. The balanced valve can be loaded with either spring, weight, or pilot. Careful selection of a regulator can be the difference between efficient and troublesome measurement.

Meter Installation

To reduce maintenance costs and to obtain maximum efficiency from the orifice meter, it is important that the meter can be installed properly. The tube run should have adequate support so that it can be kept level. It can be installed close to the ground on a concrete base, or on "A" frames about 30 inches high. If installed close to ground level, the by-pass is installed at the same height, parallel to the meter; when installed on "A" frames, the by-pass is installed about 18 inches below the meter.

The orifice fitting should be aligned perfectly with the tube. Care should be taken that no part of the gasket extends into the tube itself. An aligning tool can be used. This tool consists of an expanding metal cylinder that holds the fitting and tube run in place while the flanges are being bolted. On a welded-neck (or screw-type) fitting the aligning is automatic, although care should be taken that the weld does not extend into the tube run.

The differential-gauge installation and the range of the gauges are important factors. The gauges should be conveniently located and easily accessible to the chart collector. There are several methods of accomplishing this. A meter leveling saddle can be used; this saddle clamps on the tube run and has a leveling device built in the saddle. This method is effective where the meter run is in a location that is easily accessible to the chart collector, and where there is sufficient room for the gauges. Probably a better method is to mount the gauges independent of the tube run. A three-inch standard set in concrete with a 3 x 2 reducer approximately 30 inches from ground level gives an adequate support for the gauge and house. A leveling flange and 2-in. x 24-in. nipple will raise the gauge to a convenient height for chart changing and maintenance. It is not advisable to fasten the standard to the tube run or by-pass if there is an excessive amount of house line or service exposed above ground. The expansion and contraction of the pipe would pull the gauge out of level, causing an error in measurement.

Inspection and Maintenance of Meter

The orifice tube requires little maintenance; it should be removed and cleaned periodically. The time interval for this operation depends on the substance being measured. The best indication of the condition of the tube is the amount of foreign matter deposited on the orifice plate. Record should be kept of the deposits on the plate at the time of each inspection.

The orifice plate should be inspected regularly for nick, pits, or excessive dirt on the upstream edge, and replaced if necessary. The orifice fitting should be inspected for ease of operation; on the senior fitting the valves should be inspected. The bottom of the fitting should be cleaned out regularly to insure proper seating of the plate holder.

If the set has a regulator, the gauge lines and diaphram should be soaped for leakage. A pressure-recording gauge should be set at outlet of the regulator periodically to check lock up and operation of the regulator. If excessive drop or poor lock up is noted, the regulator should be overhauled, new seats installed, and the valve chamber cleaned. If the regulator is pilot loaded, the pilot should be cleaned and all static lines checked for leaks.

Frequent inspection of the differential gauge is necessary. At inspection, the gauge should be checked for accuracy. This is done by connecting a water manometer to the high-pressure side of the instrument, leaving the low-pressure side open to air. Pressure is then applied to the high side of the instrument and the water column until the pen records several differential units. Pressure is released and the pen action observed. If the pen falls slightly below zero, comes back above zero, then settles on zero, the gauge is free of friction. Then the meterman can begin the calibration check. Pressure is again applied to the high side of gauge and the pen record is compared with the manometer reading. This procedure is continued through the full range of the gauge. Pressure is then released and the same comparisons of the open and water column are made on the downward travel of the pen. If these readings are identical, the gauge is in excellent condition. If the gauge reads consistently higher, the gauge is fast. This can be remedied by lengthening the float arm. If the readings are lower than the manometer, the gauge is slow and can be speeded up by shortening the float arm.

If the readings taken while going upward on the chart do not correspond with those on the downward travel, the mercury may be contaminated or there may be condensate in the meter, lost motion due to worn parts, or friction. Rust or dirt in the chambers or on parts can cause the friction. A leak in the pen stuffing box also can produce erratic reading.

If the gauge checks in the lower range and higher range and not in the middle range, a bent differential shaft is indicated. If any one or more of these troubles are encountered during inspection, the gauge should be overhauled completely. If previous records show satisfactory calibration the adjustment block should not be disturbed.

In reconditioning the instrument, the cover plates of both high and low side are removed. The mercury is then drained from gauge, and all parts disassembled. These parts are sight checked for wear. When the shaft is removed, take care that you do not bend it or disturb the adjustment block. The chambers should be wire brushed and washed free of any scale or dirt, and the parts cleaned in carbon tetrachloride. The "U" tube is cleaned and flushed to insure perfect freedom of movement.

Before reassembling parts, check the bearing shaft to make sure it is not bent. This can be done by placing it on a smooth surface and rolling back and forth to determine if the shaft is straight. The bearing surfaces should be smooth and clean. To assure this, bearings and shaft are assembled without the adjustment block, a small amount of fine grinding compound is placed on the bearing surfaces, and the shaft is rotated until bearings are free of dirt and rough spots. If a new bearing or shaft is being installed, the same method is used to grind in new bearing. The adjustment block then is installed and the block secured to the shaft, making sure that the float is perfectly vertical to the sides of the pot and centered so that there is no possibility of the float touching the sides of the chamber.

If the gauge has the old-style stuffing box, care should be taken in packing; an approved method includes the insertion of a perminite washer. This is followed by a graphite-and-oil impregnated washer and a second perminite washer. The three then are forced into the stuffing box with a piece of copper tubing. The packing follower then is replaced. When tightening, the follower shaft should be rotated to be sure that the packing does not bind on the shaft.

When all the gauge parts have been assembled, the gauge is checked for level by placing a level across the machined parts of the meter body. The pen arm is fastened to the shaft and set to read approximately 3/8 inch below zero. Then clean mercury is poured slowly into the pots until the differential pen rests on zero. The high-pressure side is replaced and the water manometer connected. The instrument is then calibrated.

The static-pressure recorder consists of a Bourdon tube with lingage to a pen; calibration is accomplished by comparing the chart reading with that of a calibrated pressure gauge. A common trouble found in the recording pressure unit is the pen riding the chart too heavily; the pen should rest on the chart so that when the chart plate is pressed in 1/8 inch, the pen will hang free. Another common trouble is condensate collecting in the lines to the recorder; the error in static reading will vary with the weight of the liquid in the lines. If liquid seal is used, the pressure pen should be adjusted to compensate for the liquid head used. Another problem is securing the cor-

rect zero settings on square-root charts; the zero setting is different for each range of static element. The proper setting may be obtained from standard tables.

Faulty measurements can be detected by careful estimating of the meter charts. Some of the things to watch for are as follows:

(1) Some meters have off peak hours where there is no flow. If the pen does not return to zero or falls below and is slow in returning, it is an indication of bending in the gauge linkage, or the differential pen is pressing on the chart too heavily.

(2) If there is pulsation or over loading on the chart, and if the pen falls below zero and stays that way, it is likely that during the overload or pulsation period mercury has been blown past the stops and into the gauge line. Another indication of this condition is when the differential pen will not record to the full range of the gauge. The mercury level should be checked.

(3) When the meter has an inlet regulator, and on off-peak periods the static pressure increases and returns during normal load, the regulator needs attention. Dirt may be causing the valves to stick, or rocks can be lodged in the seats. This condition should be remedied immediately because serious damage could result from the increased pressure on the facilities connected to the outlet of the meter.

(4) Pulsation lines covering only a small portion of the chart also indicate faulty regulation. The cause could be either a worn or dirty regulator, or possibly the orifice size is too large for the load. The reason for this pulsation is that during low flow the seats of the regulator are riding too close to the orifice. This can set up a fluttering action, or cause the regulator to close completely. This starves the outlet and the regulator tries to overcome this and opens too rapidly, thus setting up continuous opening and closing action causing the false reading on the recording gauge. The orifice should be sized so that on minimum flow the regulator will open sufficiently wide to relieve this condition. Where a condition of this kind is critical, parabolic valves should be used.

Many other minor faulty conditions can be caught by careful processing of the orifice charts, including slow or fast clocks, pens out of arc, and wrong plate sizes. Field men cannot be expected to catch all of these things; unless there is proper contact and cooperation between field and office groups, the metering efficiency may go down and maintenance costs may increase.

Calculations for Natural Gas

ORIFICE-METER COEFFICIENTS

Use of handbook tabular data makes possible rapid calculation of orifice-meter coefficients. Two examples—one for regular charts and one for square-root charts—illustrate the steps necessary.

By H. R. GARABRANT
Southern California Gas Co.

BASIC HANDBOOK used by the gas companies in Southern California to calculate natural-gas volumes passing through standard orifice-meter runs is Bulletin TS-402, reprint August 10, 1948, published by the California Natural Gas Association, 510 W. 6th St., Los Angeles 14, Calif. This bulletin is for orifice meters from 2 to 20 inches in diameter operating from 25.5 inches mercury vacuum to 500 psi. gauge pressure, with natural gas at temperatures from 40 to 180 deg. F.

Quantities of natural gas measured by orifice meters are generally computed by the formula:

$$Q = C'(hP_2)^{1/2}$$

in which Q is quantity rate of flow in standard cubic feet per hour, C′ is hourly gas coefficient adjusted for actual flowing conditions, h is differential pressure across orifice (inches water), and P_2 is pressure of flowing gas at downstream pressure tap (psia).

There are two types of charts that are used on orifice meters—regular and square root. Regular charts have evenly spaced lines. Square-root charts have lines with graduated spacing so that figures read from the scale are the square root of the values being recorded.

Depending on the type of chart, there are two formulas for C′: Regular charts:

$$C' = C \times F_{e2}F_R \times F_{PV} \times F_GF_T$$

Square-root charts:

$$C' = C \times M \times F_{e2}F_R \times F_{PV} \times F_GF_T$$

C is standard hourly natural-gas coefficient giving results in standard cubic feet per hour, at 14.73 psia. and 60 deg. F., and where all correction factors for expansion, Reynolds' number, superexpansibility, specific gravity, and flowing temperature are equal to unity.

M is square-root chart factor $= 0.01\ (R_bR_p)^{1/2}$, where R_b is maximum differential-pressure range (inches of water) and R_p is maximum static-pressure range (psia.).

F_{e2} is expansion factor where pressure is taken from the downstream tap (P_2).

F_R is Reynolds' number factor. Values of F_R are for an average paraffin-base natural-gas having a viscosity of 0.0000069 lbs. per ft. sec., a specific gravity of 0.65 and a temperature of 60 deg. F.

F_{PV} is superexpansibility (supercompressibility or deviation) factor to convert the theoretical density of the gas at flowing conditions, as computed by Boyle's and Charles' law, to the actual flowing gas density.

F_G is specific gravity factor $= (1/G)^{1/2}$

F_T is temperature factor $= (520/T)^{1/2}$

Examples

Let us calculate a coefficient, using the tables in the California Natural Gasoline Association Bulletin TS-402. Note the steps for filling in data on a worksheet and calculation of C′. The first eight steps are data necessary to have before a calculation can be computed. The first 4 items are data that

The *Accurate* Way to Measure Extreme Temperatures *at a glance*

The Simplified Optical Pyrometer

SELF-CONTAINED. No correction charts, no accessories, no up-keep. Direct-reading.

ACCURATE. Permits *close* and *rapid* temp. determination—even on *minute spots, fast-moving objects, smallest streams.* ("Special Foundry Type" and "Triple Range" also have RED Correction Scale for determining *true spout* and *pouring* temps. of molten iron, steel in the open.)

LIGHT IN WEIGHT—Only 3 lbs. complete. Handy.

PROVED IN USE—Thousands in daily use.

Stock Ranges 1400° F. to 7500°F.

Write for FREE Catalog No. 85—also catalogs on PYRO Surface, Radiation, Immersion and Indicating Pyrometers.

THE PYROMETER INSTRUMENT CO.
Plant and Lab.
BERGENFIELD 4, NEW JERSEY

In Canada, Sales and Repair Laboratory: Dominion Flow Meter Company Limited Toronto and Montreal

For more information circle **73** on inquiry card.

CONFIDENTIAL MAP FILE

Easiest way to file and find maps, blue prints, tracings, etc. Metal cabinet file with locking doors. 112 tilting tubes handle 60" prints. Tubes are indexed for quick location.

Also available in entire fire-resistant safes, portion of safes and custom-built wood cabinets to match executive office decor.

Patent No. 1610368.
Other Pats. Pending.

Write today for illustrated folder.

SCOTT-RICE CO.
608 S. Main Tulsa 3, Okla.

For more information circle **74** on inquiry card.

CALCULATION OF COEFFICIENTS

Step	Symbol	Description	Example	Sample 1	Sample 2	Remarks
1	D	Size of meter run and fitting	8"	6"	16"	Given data
2	P (pipe) F (flange)	Type of tap	F	P	F	ditto
3	d	Orifice size	4.000"	2.500"	3.000"	ditto
4		Orifice-meter range				
	R_p	Max. static pressure	250#	100#	500#	ditto
	R_h	Max. diff. pressure	50"	50"	50"	
5	P_2	Average static pressure for regular chart			300#	ditto
	P_{s2}	for square-root chart	6.96	6.83		
6	h	Average diff. pressure for regular chart			7.6"	
	h_s	for square-root chart	4.2"	4.9"		ditto
7	G	Specific gravity of gas	0.668	0.629	0.652	ditto
8	T	Temperature of gas (F.)	73	87	64	ditto
9	h/P_2	For determining $F_{c2}F_R$	0.1			From Table I, pages 6-11
10	Ext. gr'p.	ditto	7			
11	M	For square-root charts only	1.1180			
12	Gauge Pressure	Directly from reg. charts				
		Table I for sq.-rt. charts	105			
13	C	Standard hourly coefficient	3364			From Table II P pages 12, 13, or Table II F, pages 16, 17
14	S group	For Reynolds' factor	1			
15	Beta	Diam. ratio, d/D	0.50			
16	$F_{c2}F_R$	Expansion and Reynolds'	1.002			
17	F_{PV}	Superexpansibility factor, corrected for temperature and dilutants (CO_2, air)	1.01			From Tables IV, IVT, and V, pages 19-25
18	F_GF_T	Sp. Gr. × Temp. Factor	1.208			From Table VI, pages 26-42
19		Step 13 × step 11 (square-root charts only)	3761			
20		Step 13 × step 16 (reg.)				
		Step 19 × step 16 (sq. rt.)	3768			
21		Step 20 × step 17	3806			
22	C'	Step 21 × step 18	4598			
		Correct coefficient		1251.0	2314	

do not change for a given meter setup; the others are data that usually are variable.

CALCULATING VOLUMES BY USE OF COEFFICIENTS

By hand reading, chart must be read hourly, and hours totaled.

For regular chart; volume for one hour equals $C'(h\ P_2)^{1/2}$.

For square-root chart, hourly volume equals $C'h_s\ P_{s2}$.

With use of an integrator (Rockwell Mfg. Co.), the volume equals C' × I × Integrator reading, where the integrating factor (I) equals $(100/500)^{1/2}$ times the number of days for one chart revolution.

Clock	*I*
24 hr.	0.4472
48 hr.	0.8944
72 hr.	1.3416

The integrator reading equals the dial reading at the start minus the dial reading at the finish.

INSTRUMENT EVENTS Calendar

January 26-27

American Institute of Electrical Engineers Scintillation Counters Conference, Washington, D. C. For information write R. S. Gardner, A.I.E.E., 29 West 39th St., New York, N. Y.

February 1-3

Fifth Annual Southeastern-Symposium on Industrial Instrumentation sponsored by College of Engineering, University of Florida, and the Instrument Society of America, at the University of Florida, Gainesville, Fla. For information write R. C. Specht, Dept. of Engineering, University of Florida, Gainesville, Fla.

February 4-6

Sixth Southwestern I.R.E. Conference and Electronics Show held in Tulsa, Okla. Headquarters in Tulsa Hotel. For information contact Dallas R. Davis, P. O. Box 4183, Tulsa, Okla.

February 11-12

Joint Institute of Radio Engineers, American Institute of Electrical Engineers, and the Association for Computing Machinery, West Coast Computer Conference, Ambassador Hotel, Los Angeles, Calif.

March 1-5

Fifth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy at William Penn Hotel, Pittsburgh, Pa. For information contact R. G. Russell, Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pa.

March 22-25

Institute of Radio Engineers Conference and Exhibit, Kingsbridge Armory, New York, N. Y. For information contact W. Copp, 1475 Broadway, New York 36, N. Y.

April 6-9

Conference on Physics of Particle Size Analysis, sponsored by the Institute of Physics, Nottingham, England. For information write Institute of Physics, 47 Belgrave Square, London, S. W. 1, England.

April 22-23

American Institute of Electrical Engineers Conference on Feedback Control, Claridge Hotel, Atlantic City, N. J. For information write R. S. Gardner, A.I.E.E., 29 West 39th St., New York, N. Y.

April 22-29

American Institute of Electrical Engineers, Electronic Components Conference, Washington, D. C. For information write R. S. Gardner, A.I.E.E., 29 West 39th St., New York, N. Y.

April 28-30

Second Annual meeting of ASTM Committee E-14 on Mass Spectrometry, Jung Hotel, New Orleans, Louisiana. For information write J. G. Hutton, General Electric Co., Schenectady, New York.

May 5-7

Third International Aviation Trade Show, 71st Regiment Armory, New York. For information write Eugene P. Connelly, Aircraft Trade Shows, Inc., Hotel McAlpin, New York 1, N. Y.

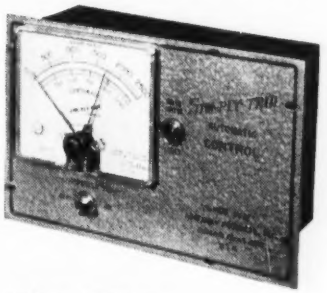
July 6-10

Joint Commission on Electron Microscopy of International Council of Scientific Unions. For information write F. W. Cuckow, Secretary General of Commission, Chester Beatty Institute, Royal Cancer Hospital, Fulham Road, London, S. W. 3, England.

AUTOMATIC—

SIM-PLY-TROL

PYROMETER
(THERMOCOUPLE TYPE)



Cat. No. 4531
Panelmount
0/2500° F.
0/1370° C.
$ 127.00 less thermocouple.

Other models from -400° to 3000° F.
(also Centigrade -240° to 1650° C.

Plug-In UNIT CONSTRUCTION
Wall Cabinet or
Flush Panelmount

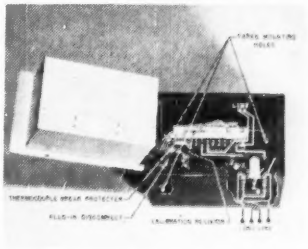
LOAD:
5 A., 115-230 V (non inductive)
40 Amps. (optional, extra)

The Simplytrol Automatic Pyrometer is a compact, on & off control or temperature shutoff device for industrial or laboratory furnaces, ovens or chemical processes.

Part of more than 60 Simplytrols in new plant of Precision Metalsmiths, Inc., 1081 East 200 Street Cleveland, Ohio.

This prominent manufacturer of precision investment castings by the lost wax process controls the heat of their gas fired furnaces with Simplytrols.

Order from this ad or
Send for Bulletin G-2
listing prices and ranges



Wall cabinet, (open) showing quick disconnect plug, terminal strip, T/C calibrating resistor and heavy duty relay, (optional).

Control unit is removable by taking out two screws and pulling quick disconnect plug.

Order from the nearest Simplytrol dealer

Assembly Products, Inc., Box 191, Chagrin Falls, O.
S. Sterling Co., 15310 W. McNichols, Detroit 35, Mich.
Electro Tech, 308 Canal Street, New York 13, New York

For more information circle 75 on inquiry card.

DIALCO
for YOUR product
WHICH PILOT LIGHT DO YOU NEED?
THE BIG ONE
This Pilot Light Assembly was first made to accommodate the S-11 lamp and was intended for use in the cabs of great diesel locomotives.
ACTUAL SIZE
Cat. #613529-211
or
THE LITTLE ONE
The miniaturization program on defense products required the development of this sub-miniature light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.
ACTUAL SIZE
Cat. #8-1930-621
Dialco HAS THE COMPLETE LINE of INDICATOR and PANEL LIGHTS
Samples to suit your own special conditions and requirements will be sent promptly and without cost. Just outline your needs. Let our engineering department assist in selecting the right lamp and the best pilot light for YOU.
Write for the Dialco HANDBOOK of PILOT LIGHTS
Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION
60 STEWART AVENUE, BROOKLYN 37, N. Y. HYACINTH 7-7600
For more information circle 76 on inquiry card.

NUCLEAR REACTORS

Continued from page 1874

boron-lined BF_3 proportional counter surrounded by paraffin with a removable cadmium cover for qualitative surveys of the thermal and epithermal neutron flux. The other thermal-neutron metering device should consist of two fiber electroscopes, one with the inside wall lined with a thin layer of boron, and the other with a normal conducting plastic or inner-wall aquadag. The two electroscopes should be calibrated so that the difference in the two readings gives a quantitative measure of the thermal-neutron flux.

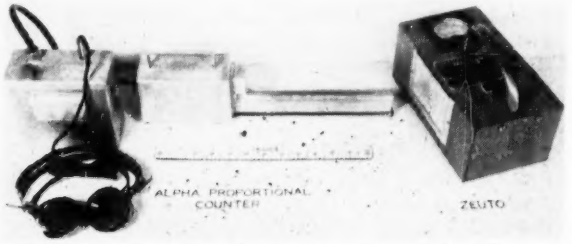


Fig. 4-5. Typical portable radiation meters—the one on the left operates as a proportional counter; the one on the right operates as an ion chamber.

Personnel Monitoring

The *personnel monitoring meters* should include a film badge and pocket meter for each person who enters the area where radiation exposure is possible. Each film badge should contain a sensitive and insensitive film for the low- and high-range beta- and gamma-ray monitoring. In addition, the film badges of those who enter areas where there are sources of neutrons (nuclear reactors, accelerators, etc.) should contain a particle emulsion film for fast- and thermal-neutron monitoring.

Auxiliary Equipment

(1) Calibration sources operated by remote control so that they can be removed from storage and mounted in place by pulleys, air pressure, or an electrical mechanism. Radium or cobalt-60 are usually used for beta and gamma calibrations, and polonium-beryllium for neutron calibration. Radium sources should be enclosed in a stainless steel or other metal container so that there will be no danger of spread of contamination due to the rupture of the source holder.

(2) Minometer for reading the pocket meters.

(3) Microscopes for counting the proton recoil tracks produced by the neutrons in the particle emulsion film.

(4) Dark-room facilities with automatic control of room temperatures and developing-solution temperature.

(5) Filter paper for smear or swipe tests to determine whether or not the surface contamination will rub off and thus spread by contact.

(6) A counter room in which smear samples, dust samples, water samples, urine samples, etc., can be counted.

(7) Equipment for the study of radioactive particles. This consists of dust-settling trays and air-samplers as described previously. Large, sensitive X-ray films are placed for about twelve hours directly over the settling trays or filter papers that have been exposed in order to microradioautograph the specks of radioactivity contamination.

(8) X-ray film that can be placed over the shielding surrounding the nuclear reactor and equipment associated with it in order to detect small beams of radiation leakage and to determine where additional shielding is required.

Waste Disposal

Waste-disposal problems are simple if the institution can maintain levels less than the general MPC values discussed previously. To determine whether these levels are

being maintained, one simply collects dust samples from a known volume of air or evaporates down a known volume of water and counts the gross activity. For radioactive gas or volatile compounds, more complicated procedures may be required.

For disposing of the waste, some institutions collect the excessively "hot" liquid and solid radioactive waste, place it in steel drums where it is mixed with concrete, and then dump the drums in the ocean. If the university has under its permanent control a hillside just above a large river, it may be practicable to dig in this hillside, a few hundred feet above the river, an open radioactive-waste-disposal pit. It must be ditched properly to prevent surface water from entering and must be surrounded by a security fence to prevent the public from having access to it for fishing or swimming. The theory behind this means of waste disposal is that most of the radioactive contaminant will be held up in the soil as water seeps toward the river, and the amount that reaches the river is then so diluted that it presents no problem. Such a method of waste disposal would not be recommended in a limestone area where there might be underground passageways in the limestone to wells or springs some distance below the waste pit. Clay and shale soils are preferable for this type of installation. In some localities it may be necessary to cover the waste-disposal pit with a roof to prevent accumulation of rainwater.

Personnel and Organizational Requirements for Protection

This is the most important section of this chapter. No radiation protection program can be successful without the full cooperation of persons at all levels—from the janitors to the university president. The scientist must remember certain "don'ts" and take added precautions when working with radioisotopes. He must not pipet by mouth and must not eat lunch or smoke in the "hot" laboratories. The instrument-maker must not blow contaminated glass or weld or bronze contaminated metals, except in especially provided hoods, and then only when wearing a gas mask. Everyone entering the radiation area must wear the personnel-monitoring meters and conform to the protective-clothing regulations. Delays and expensive clean-up procedures can be caused if anyone carelessly tracked radioactive contamination from the site of a spill in the laboratory to a counting room or to the cafeteria. Everyone associated with these activities must have a clear understanding and full appreciation of the radiation hazard problems. One must not fear radiation, but must have a proper alertness to its dangers.

The most essential part of the entire program of radiation protection is that of securing the services of a competent health physicist. In fact, if such a person is employed during the initial planning, and if this person has proper authority and active support from officials of the university and the cooperation of the faculty, many of the problems mentioned will be taken care of by him with a minimum of worry and inconvenience to the others involved. A number of universities are employing health physicists and consider them an essential part of the university research program. These universities have found that such a person saves the time and effort of others and can mean a great saving in construction and operating costs. Without such a person and an adequate radiation protection program of the type he is trained to set up, there may well be cases of radiation injury to personnel and serious building contamination.

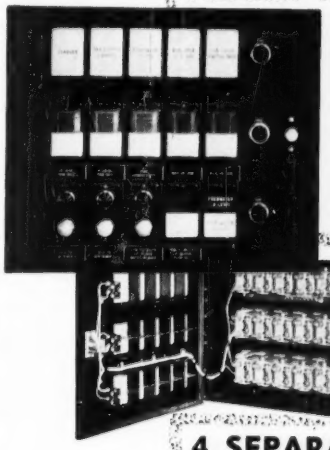
Personnel within and in the environs of the university must be protected from radiation damage in order to carry out the objectives of the university. Moreover, radiation protection is desirable in order to avoid legal complications. Every precaution must be taken to avoid contamination of buildings and consequent damage to personnel, interference with experimental work, and the heavy costs of decontaminating a building. Accurate records must be maintained of all radiation exposures—both zero and positive readings—to personnel, and of the level of contamination in and about the university. The details of the health physics program will vary from place to place, but the

Only

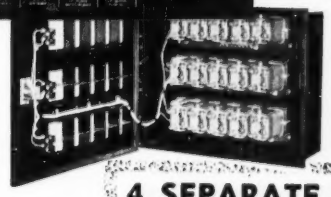
TEL-ALARM

Can Give You This Complete Flexibility and Versatility!

5 TYPES OF VISIBLE ALARM INDICATIONS



are shown in this typical installation. Includes back-lighted nameplates, turret lenses and bullseyes, all grouped for quick indentification.



4 SEPARATE CIRCUIT SEQUENCES

are used in the uniform assembly of the Relay Plug-Ins and Chassis.

Only Tel-Alarm unitized construction makes possible such various signal combinations in any number of alarms; all furnished in standardized components assuring reliability, efficiency, low cost.

This Self-Contained TEL-ALARM PLUG-IN-UNIT is a marvel of efficiency for alarm signal service. Over 100 variations in Circuit Sequences are possible in one uniform plug-in unit.

FOR FULL INFORMATION WRITE FOR BULLETIN 440

TEL-ALARM by Tigerman Engineering COMPANY

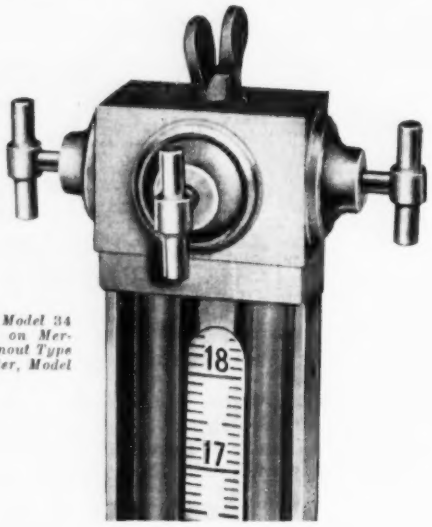
4332 North Western Avenue • Chicago 18, Illinois

For more information circle 77 on Inquiry card.

DAHL
Engineered
CONTROLS

The Valve That Stole The I.S.A. Show . . .

"Demi" Model 34, packless 3 valve manifold for vacuum or high pressure service. Manufactured from barstock, it has 3 packless valves in one body, two isolating and one by-pass valve. Designed primarily for manometer mounting, the "Demi" Model 34 has various other instrument applications.



"Demi" Model 34 mounted on Meriam Cleanout Type Manometer, Model B-1103.

Model 1012, as shown, for direct mounting on clean-out type manometer.

Model 1011 with integral unions for gland packed type manometer.

Model 1006 with ¼ inch I.P.S. connections for various other instrument applications.

All models available in brass, steel, aluminum or stainless steel.

George W. DAHL Company
BRISTOL, RHODE ISLAND

For more information circle **78** on inquiry card.

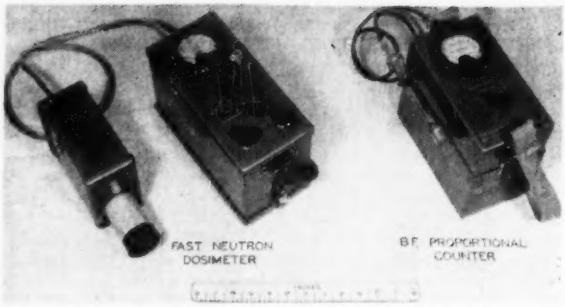


Fig. 4-6. Fast-neutron and slow-neutron survey meters.

health physicist in charge will be able to adopt a program suitable to the local situation. For example, he might find it expedient initially to make use of a film meter service offered by several outside agencies, instead of employing an extra technician to carry on this expensive part of the program.

There are approximately fifty persons graduated from the health physics training programs in the United States each year. Their number is not enough to meet the demand, but as universities recognize their own needs they should encourage some of their most intelligent young physics majors to take a year or more of graduate training in this new and interesting field and thus help to supply the deficiency.

The most difficult task of the health physicist may well be to re-educate some of the older research workers in the university to do things differently and safely. For example, some people who have worked with X-ray machines or cyclotrons for years will now be told that they are using inadequate shielding, or there may be those who are told they must handle sources with tongs instead of with their bare hands. The claim of these men is always that they have done things in their own way for years without body-damage, and they do not understand why they should change now. The answer, of course, is that it may take ten or fifteen years for a bone cancer or lukemia to show up, or there may already be the initial developments of skin cancer which they do not recognize from the changes of the skin on the hands, or that the slight impairment in their sight may be due to the early stages of radiation cataracts and not to the fact that they are ten years older than when they joined the university staff.

The organizational set-up should be such that the senior health physicist will report directly to the president or the person in charge of all the research involving ionizing radiation in the university. He must be in charge of the radiation protection program throughout the entire university, and he must have authority to establish and enforce his program. He will need an operating budget that may be in general about five percent of the operating budget devoted to work with ionizing radiation. He must be responsible for selecting and training his own staff of assistants.

A school that has a limited program of work with ionizing radiation and that is contemplating the installation of a high-voltage accelerator or a swimming-pool-type nuclear reactor may be able to employ on a part-time basis a student who has completed a year of graduate training in this field and has received his M.A. degree in Health Physics. Several universities have employed such students who are working part-time as health physicists in charge of the radiation protection program and who, in the remainder of their time, are taking courses and doing research to meet the requirements for a Ph.D. degree. This method has the advantage that it is probably the most economical way to institute a university program with ionizing radiation, and also that it gives the young health physicist the opportunity to develop with the program.

As a final word, the health physicist is not a policeman but a fellow scientist. He must have the confidence and respect of those with whom he works. As his responsibilities cut across all divisions of the university, it is helpful if an Advisory Committee on Radiation Protection is

formed. This Committee should have representation from all groups involved with radiation protection and should serve as a medium for the exchange of information and for the enlightenment of those responsible for conducting research with ionizing radiation in a safe and acceptable manner.

STEEL-PLATE THICKNESS

Continued from page 1881

to the saturation induction in the plate under examination. This leakage flux is kept small by providing a large annular space between the pole and the outer annulus in designing the pot-magnet. The relative dimensions and air gaps in the secondary and main magnetic circuits affect the sensitivity to presence of non-magnetic gap between the measuring head and the plate surface.

Construction Details

The main magnetic circuit consists of an outer cylinder and a center pole of soft iron. Between the inner disk A and the outer cylinder is an annular magnetic gap obtained by interposing a ring of brass approximately 0.015-inch thick. The main excitation wi..ding consists of 450 turns of 20 s.w.g. annular copper wire, operated at a current of 3.6 amperes. The moving-coil movement in the secondary magnetic circuit is a standard commercial milliammeter element.

The compensating coils are connected in series with the main excitation (Fig. 5) and provide a backing-off magnetomotive force in the secondary magnetic circuit. They consist of approximately 10 turns of 20 s.w.g. wire. A push-button switch in the handle of the instrument controls the excitation current. Rheostat R_2 adjusts the main excitation current. Rheostat R_1 and milliammeter M_1 provide a means of adjusting the moving-coil current to a desired value depending on the B_{max} value of the particular material being examined.

The indicating meters and controls are situated in the control box shown in the left-hand side of Fig. 1, which shows the measuring head on a sample steel plate.

Operation is simple—it is necessary only to place the measuring head on the surface being studied, press the button to provide the magnet excitation, and then observe the reading.

Performance

The instrument described is designed for use on steel plates up to 0.25-inch thick. The calibration curve is shown in Fig. 6. On normal machined surfaces the error is less than 3½ percent of the scale reading or 0.003 inch, whichever is greater. The moving-coil current has a large effect

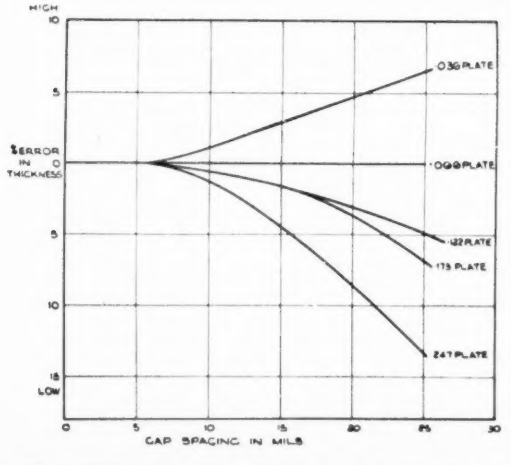
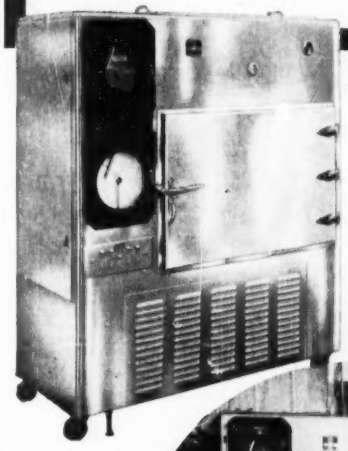


Fig. 7. Effect of gap between instrument and metal surface.

FOR PRECISE AND RELIABLE ENVIRONMENTAL TESTS

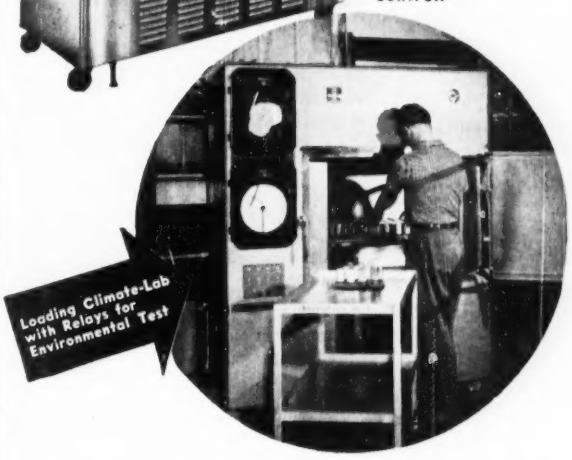
AMINCO **CLIMATE-LAB**

Humidity-Temperature TEST APPARATUS With Program Control



Widely used by industry and government for producing conditions required by U.S. Armed Forces for acceptance testing in accordance with various program schedules.

Equally adaptable to atmospheric corrosion studies, development and quality control.



Loading Climate-Lab with Relays for Environmental Test

The Climate-Lab is ideal for testing the performance and durability of materials and devices under specific climatic conditions. It consists of a test chamber, air-conditioning unit, and control system, all embodied in a compact unit which affords precisely controlled variations of humidity and temperature repeated periodically according to predetermined programs, and provides a chart record of these variations.

FOUR TYPES OF HUMIDITY-TEMPERATURE CONTROL

1. Constant humidity and constant dry-bulb temperature.
2. Constant humidity and varying dry-bulb temperature.
3. Varying humidity and constant dry-bulb temperature.
4. Varying humidity and varying dry-bulb temperature.

Write for Bulletin 2242-H

AMINCO *Laboratory Instruments*

AMERICAN INSTRUMENT COMPANY, INC.

Silver Spring, Maryland • In Metropolitan Washington, D. C.

For more information circle **79** on inquiry card.

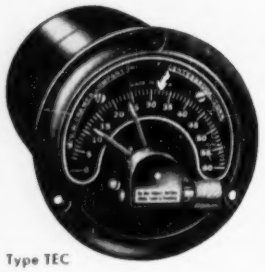
LEVIN®
MICRO-DRILL PRESS
for holes as small as .002"

Designed to hold small drills in precision collets. Absence of a sliding quill guarantees extreme sensitivity with finger-tip control. A mounted ⅛" capacity drill chuck can also be used.

Write for Bulletin H describing the Micro-Drill Press and listing collet sizes. Louis Levin & Son, Inc., 782 E. Pico Blvd., Los Angeles 21, California.

For more information circle 80 on inquiry card.

Cramer TIMING DEVICES
time delay relays



Type TEC

PROVIDE POSITIVE CONTROL FOR VITAL PROCESSES AND EQUIPMENT

- *Accurate* . . . Repeat accuracy, ½ of 1%. Overall accuracy (inclusive of setting), 2%.
- *Easy to Set* . . . Micrometer adjusting knob insures extremely precise setting. Special progress pointer indicates unexpired time.
- *Positive Clutch* . . . Serrated face-plate clutch insures positive engagement.
- *Totally Enclosed Switch* . . . Quick make, quick break. Handles 10 amps., non-inductive at 110 volts.
- *Extra Strength Motor* . . . High torque Cramer motor provides extra reserve strength.

Write for complete information.

the R. W. CRAMER CO., INC.
BCR53 BOX 5, CENTERBROOK, CONN.

For more information circle 81 on inquiry card.

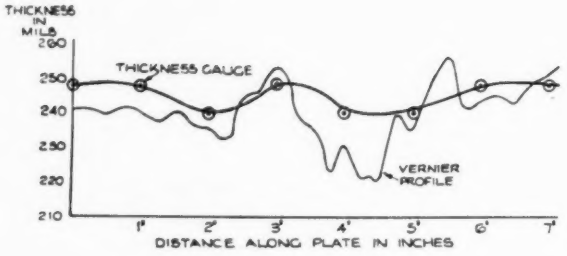


Fig. 8. Effect of deep pitting of surface.

on the instrument reading and should be carefully set to the required value before making measurements.

The calibration holds within the limits of error stated for a range of carbon steels up to 0.4-percent carbon and also for low-alloy steels such as low-alloy manganese, chromador, copper chrome, and low-copper steel.

The effect of poor contact between instrument and surface under study was investigated by inserting nonmagnetic shims under the instrument measuring head. The results are shown in Fig. 7. In the worst case a gap of approximately 0.015 inch produces an error of about 5 percent, from which it can be concluded that reliable measurements can be made on surfaces covered with a thin coating of paint or rust. Errors shown in Fig. 7 are much less than those found with other magnetic-type thickness meters.

Experiments were carried out on pitted surfaces to determine the effect of surface profile on the instrument reading. A sample plate, approximately 14" x 8" and ¼" thick, with deep pitting (resulting from atmospheric corrosion) on one face was used in this experiment. Fig. 8 shows a line profile across the plate, which was plotted by vernier caliper at intervals of ¼ inch along the plate. Plotted to the same scale is shown the thickness profile as determined by the thickness meter at 1-inch intervals along the same line. The results show that the thickness meter reading is less affected by deep surface pitting. In making thickness measurements of this plate with the instrument from two opposite faces, one pitted and one smooth, no appreciable difference in readings was observed.

References

1. Thornton, B. M., Proceedings of the Institution of Mechanical Engineers, Vol. 140, 1938, page 349.
2. Warren, A. G., Proceedings of the Institution of Electrical Engineers, Vol. 84, 1939, page 91.
3. Benson, Carlin, *Electronics*, Vol. 21, No. 11, 1948.
4. Branson, N. G., *Electronics*, Vol. 21, No. 1, 1948.
5. Roberts, A. C., *Mechanical Measurements by Electrical Methods*, Instruments Publishing Co., Pittsburgh, Pa.
6. Thornton, B. M., and W. M. Thornton, Proceedings of the Institution of Mechanical Engineers, Vol. 123, 1932, page 745.
7. Smith, G. S., Proceedings of the American Institute of Electrical Engineers, Vol. 56, 1937, No. 4.
8. Briggs, J. H. and W. H. Mitchell, *Journal of Scientific Instruments*, Vol. 26, 1949, No. 2.
9. Carlisle, S. S. and B. O. Smith, *The Engineer*, Dec. 21, 1951.

FLOW TUBES

Continued from page 1879

much higher differentials. This permits less contraction for a given meter head, where head loss is important. It's greater sensitivity is an advantage when metering low-velocity fluids.

(4) Owing to the compactness of the Flow Tube, it can be installed in that part of the hydraulic system most conducive to good results. It can be installed in the plant, eliminating expensive masonry vaults often necessary for other conventional head meters. Moreover, the distribution of the nozzles around the inner periphery, which can be increased in number as required, makes the tube less sensitive to extreme installation conditions. This is due partly to the averaging effect of the nozzles and partly to the fact that the velocity gradient across a contraction such as the throat of a Flow Tube is much flatter than it is in the pipe itself. With suitable calibrations using piping arrangements simulating the actual installation, Flow Tubes

can be installed without any straight entering run, except before and after valves.

(5) In "Types D, V and VDM," both the high-pressure and low-pressure nozzles are located at the smallest diameter of the throat. There is no change in velocity or pressure between the upstream and downstream nozzles. When metering gases, then, it follows that there is no expansion between the high-pressure and low-pressure nozzles and no need for an expansion factor. In other words, the simple hydraulic formula $V = \sqrt{2\,gh}$ applies, so long as h is expressed in feet of fluid at the throat density.

The Flow Tube is relatively new, having been on the market only about five years. However, it is now being used widely by major industrial corporations for metering water, sewage, steam, gas, oils, and chemicals. They give satisfactory results even when installed under unfavorable conditions. In a Pittsburgh coal-gasification plant, a 6-inch "Type-D" Flow Tube is installed immediately following an elbow, and is giving an accuracy of better than one percent. In a New York aircraft plant a "Type V" Flow Tube, with the negligible ratio of contraction of 1.1 to 1 (practically a straight piece of pipe) is metering jet fuel over a range of better than 10 to 1, giving differentials in the order of 150 inches of water with no head loss except that due to straight rubbing friction.

Although the Flow Tube was designed for industrial metering, it has applications in other fields. It can be used as a proportional meter with a positive displacement meter in the shunt path between the high- and low-pressure piezometer rings. As the device is compact, it can be used on ship-board. The "Type V" Flow Tube appears well suited for experimental work in the transonic and supersonic ranges; it can be designed without any contraction or projections in the streampath.

TINPLATE

Continued from page 1875

controls developed to date involves a happy combination of standard direct-current ammeter shunts, a potentiometer-type indicating-recording controller, an electronic amplifier, and a combination of direct-current generators. This regulating system is capable of an accuracy of plus or minus one percent or better. The total current at any speed is readily adjusted by varying the pilot generator signal, thus allowing adjustment of coating weight.

After plating, all traces of plating solution are removed by passing the strip through a solution-recovery tank, scrubber, hot-water rinse, and dryer. Automatic control of temperature in the solution recovery and hot-rinse tanks contribute to proper operation and permit delivery of strip from this section at a consistently high temperature. This is important because the next operation consists of raising the strip temperature sufficiently to produce fusion of the tin coating, and this is more readily accomplished if the strip temperature is already high.

The tin coating as applied in the plater has the matte surface typical of electroplating, and as such is not an acceptable product for most commercial applications. In order to produce a bright reflective surface the tin coating must be fused; this process is known as *reflowing*, or *brightening*. The fusion of the tin coating requires a temperature of approximately 400 deg. F. and, as the strip leaves the hot rinse and dryer at a maximum temperature of 180 to 200 deg. F., the temperature must be raised 200 to 220 deg. F. One of the most successful means for accomplishing this has been the use of radio-frequency induction heating, although electric-conduction heating and gas-furnace heating also have been used. The use of radio-frequency induction heating has permitted the utilization of a unique control system for regulating the power of the induction heater. As the output of the electronic oscillators used to produce the radio-frequency energy can be varied rapidly it has proved practical to detect the point at which the tin fuses and to use this data to control the radio-frequency

Engineered Air Regulation

WHAT DO YOU REQUIRE OF AN AIR REGULATOR?

IS IT CAPACITY?

Kendall Model 10 Air Pressure Regulator gives up to 35 CFM with 90 PSI supply pressure

IS IT ACCURACY?

Increasing flow overcomes downstream line losses by jet tube venturi action in the Kendall Model 10

IS IT FREEDOM FROM SUPPLY PRESSURE INFLUENCE?

50 PSI variation in upstream pressure will result in less than 0.05 PSI change in downstream pressure on dead end service when you use a

KENDALL MODEL 10 AIR PRESSURE REGULATOR

AVAILABLE ¼" or ⅜" N. P. T.
RANGES 0-2, 10, 30, 60, 150 PSIG
Send for BULLETIN 4521

KENDALL CONTROLS CORPORATION
144 MOODY STREET WALTHAM 54, MASS.

For more information circle 82 on inquiry card.

CAMBRIDGE GAMMA-RAY POCKET DOSIMETER

This personnel monitoring instrument measures the cumulative exposure to gamma or x-rays over a given period of time. The instrument consists of an ionization chamber, a quartz fibre electrometer and a graduated scale and viewing system. The charging unit comprises a 180 volt "B" battery, a 1½ volt "A" battery, a flashlight bulb, the well for inserting Dosimeter, and the charging control.

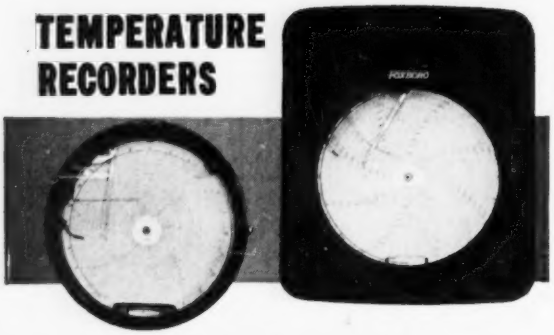
SEND FOR BULLETIN 300 G.D.

Other Cambridge Instruments for measuring radioactive emission are the Lindemann-Ryerson Electrometer, "Chang and Eng" Fast Neutron Detector and the Precision Ionization Meter (Failla Design).

CAMBRIDGE INSTRUMENT COMPANY, INC.
3742 Grand Central Terminal, New York 17, N. Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle 83 on inquiry card.

TEMPERATURE RECORDERS



to avoid lost profits

Accurate Foxboro Temperature Recorders give you a minute-by-minute report of process conditions — an invaluable aid in determining future operation. Moreover, the records forecast impending difficulties — permitting corrections to be made before costly trouble starts.

Available with vapor pressure, gas pressure, or liquid expansion type systems. Choice of 50 standard bulbs; 700 chart ranges and scales from −450° to +1000°F. Round or rectangular cases for all operating conditions. Exclusive Foxboro design and construction advantages detailed in Bulletin 447. (Temperature indicators and controllers also available.) Write **The Foxboro Company, 4612 Norfolk St., Foxboro, Mass.**

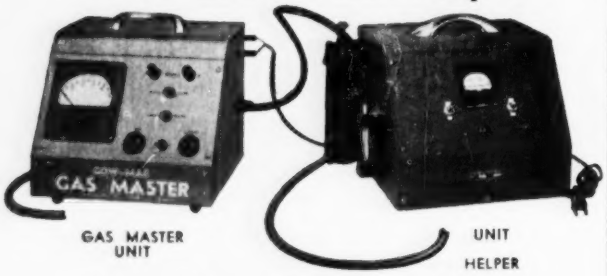
FOXBORO TEMPERATURE RECORDERS

For more information circle **84** on inquiry card.

FOR LOW COST GAS ANALYSIS

GOW-MAC GAS MASTER

–and Gas Master Helper



A versatile portable Relative Thermal Conductivity Instrument Featuring

FAST RESPONSE AND HIGH REPRODUCIBILITY!

Widely used in field, plant and laboratory. Monitors manufactured and natural gas mains with ease providing high accuracy during purges and changeovers. Write for new BULLETIN GMH-853 mentioning your specific problem.

GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.

For more information circle **85** on inquiry card.

output so that the tin fuses the instant before the strip leaves the induction heating coil, thus avoiding overheating and permitting maximum utilization of available power. The point of fusion is detected by a photoelectric eye which is actuated by the difference in reflectivity of the fused and unfused tin coating. The regulating system is primarily electronic and is responsive enough to follow all normal variations in line speed, strip thickness, and coating weight with almost unerring precision.

After brightening, the strip is passed through a temperature controlled quench tank and dryer to the vapor oiler. Commercial practice requires that tinplate be very lightly oiled. This is accomplished by atomizing oil at a controlled air pressure and then depositing the oil electrostatically on the strip in an essentially monomolecular film. So efficient is this method of oiling that two drops of oil are spread over an area equivalent to that of a nine-foot by twelve-foot rug. After oiling, the strip is rewound into coils, or sheared to size specified by the consumer.

Although instrumentation of tinning lines already has progressed considerably, it is evident that there are still fields for further development. Some have been suggested; others are (1) an instrument to indicate continuously the thickness of the tin coating, (2) means for indicating and regulating strip tension as it proceeds through the line, (3) a reliable and simple indicator for slippage between strip and rolls, and (4) an inspection device to indicate surface defects.

PROFILOMETER

Continued from page 1883

lead screw across the width of the recording paper according to motion of the Y control knob. This recorder gives a two-coordinate plot of the bore profile in terms of the motion of the X-Y control knobs. As readings of the control knobs can be plotted only when the probe-arm mirror has been reset to its reference inclination, the recording pen only dots the recording paper when a push button is operated. The profile is thus plotted as a dotted curve whose resolution depends on the intervals between setting of the X control knob at which the null balance is made.

The gear ratios employed give magnification of $\times 40$ and $\times 20$ in the X direction, and $\times 80$, $\times 40$, or $\times 20$ for vertical motion of the probe tip (the actual profile variation). Deformities in a die profile of 0.5 thousandth are clearly shown on the record.

Performance

The profilometer can draw profiles with a consistency of measurement better than 0.1 thousandth. The time taken to draw a complete profile depends on the number of points at which the profile is inspected along the length of the bore; experience has shown that 30 minutes is ample to plot a complete top and bottom profile, and of this time approximately 15 minutes is spent in taking readings. This time is reduced by use of the recorder.

An automatic null-balancing system is now under development. In this device the autocollimator is replaced by a photocell system which, like the autocollimator, responds to small changes in angle of tilt of the mirror, but which gives an electrical signal corresponding to deviation from the normal balance position. This signal is amplified and applied to a servo motor which operates on the Y control knob so as to restore automatically the angle of tilt of the mirror to its initial arbitrary setting. Initial trials with an automatic system of this type have shown that the time to plot a profile to an accuracy of 0.1 thousandth will be about a minute.

References

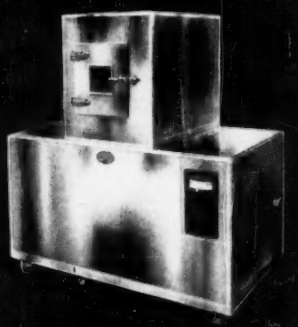
1. Wistreich, J. G., *Journal of the Iron & Steel Institute*, Vol. 158, 1948, p. 496.
2. U.S.A. Patent No. 2444639, March 11th, 1944.
3. Lueg, *Stahl und Eisen*, Vol. 70, 1950, p. 634.
4. Withers, R. M. J., *Journal of the Iron & Steel Institute*, January, 1950, p. 63.

WEBBER

TRADE MARK REGISTERED

TEST CHAMBER

WITH HIGH-TEMPERATURE, LOW-TEMPERATURE AND HUMIDITY



★ This Webber test unit, designed for production and experimental testing, has a temperature range from +250°F., to −100°F. The pull-down to −100°F., is achieved in 45 minutes, and can be cycled from −100°F., to +250°F., in 30 minutes. 95% relative humidity is provided at temperatures between 75°F., and 95°F. Vacuum equipment can be added to simulate high altitudes. The test chamber, provided with a moisture-proof light for illumination, is 4½ cubic feet, 20 inches high, 20 inches wide, 20 inches deep. High and low temperatures are governed by a temperature controller with scale range from −200°F., to +400°F., with a 3 degree control point differential, 1½ degrees plus and minus. The humidity is regulated by a wet and dry bulb controller. Unit size is 60" long, 45" wide, 74" high. Apertures in left side of cabinet provide for electrical cables to energize equipment being tested. Webber offers a complete line of test units for various applications.

Write for more complete information

INDUSTRIAL FREEZER DIVISION
WEBBER MANUFACTURING COMPANY, INC
Formerly Webber Appliance Co., Inc.
2740 MADISON AVENUE, INDIANAPOLIS 3, INDIANA

For more information circle **86** on inquiry card.

Wallace & Tiernan

MASSOMETER

FOR METERING FREE FLOWING SOLID MATERIALS

Pneumatic Recording
•
Maximum Capacity 225 lb. per min.
•
Accuracy ±1%
•
Overall Height—24½ in.

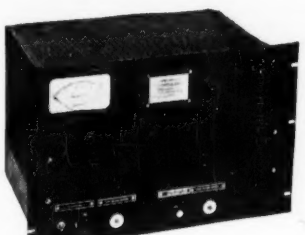
M-28

Write today for Description

WALLACE & TIERNAN COMPANY INC.
25 MAIN STREET, BELLEVILLE 9, N. J.

For more information circle **87** on inquiry card.

SPELLMAN HIGH VOLTAGE POWER SUPPLIES



MODEL LAB-40

Continuously variable regulated 25 to 40KV unit with a 4 to 6 KV focus tap for use with flying spot kinescope recording tube, projection TV, etc.
Regulations of 0.5% at 1 milliampere.
Standard Rack Model—19" wide x 12" high x 13" deep.
Standard Bench Model—21" wide x 14" high x 15" deep.

With meter $620 net
Less meter $545 net

MODEL 4575 4½ KV POWER SUPPLY

$32.50 Net

This compact, well designed, ruggedly built DC supply has an output voltage of 4½ KV at 1 milliampere. By varying the DC input the output voltage can be varied from approx. 1 KV to 7½ KV. Dimensions 5¾" H x 5" D x 4¼" W.
Model 4575 less low voltage DC supply

SPELLMAN TV HAS A COMPLETE LINE OF HIGH VOLTAGE RF Type DC POWER SUPPLIES

ALSO AVAILABLE: 0-100,000V DC, 10 milliampere High Voltage oil-filled power supplies.

SEND FOR COMPLETE INFORMATION

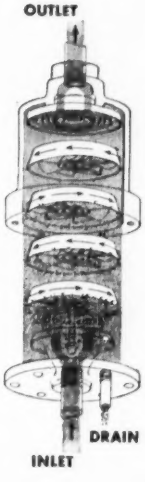
SPELLMAN TELEVISION CO., INC.
3029 WEBSTER AVE. NEW YORK 67, N. Y.
KI 7-0306

For more information circle **88** on inquiry card.

EQUIPMENT LASTS LONGER ...PERFORMS BETTER... when the

ARIDIFIER

SCRUBS, CLEANS AND DRIES On Air and Gas Lines

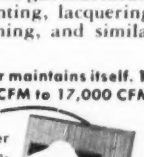


LASTS LONGER because...
The Aridifier's patented centrifugal-baffle action traps 92% of all dirt, oil, scale and water in gas or compressed air . . . and drains off these troublemakers *before* they can damage tools and equipment.

PERFORMS BETTER because...
The Aridifier protects tools against the freezing, fouling, caking and corrosion caused by dirt and foreign matter . . . assures the clean, dry air and gas that means better spray work, painting, lacquering, sand blasting, air cleaning, and similar operations.

Easily installed, the Aridifier maintains itself. 10 models. Capacity range; 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.
Write for This Catalog Now!



Logan ENGINEERING CO.
4921 W. Lawrence Ave., Chicago 30, Ill.

For more information circle **89** on inquiry card.

amplifiers
AND COMMUNICATION EQUIPMENT

Line, bridging and power amplifiers for precision-laboratory-audio frequency work. Also magnetic recording oscillators, pre-amplifier-equalizers . . . gain sets . . . volume indicators . . . vu meters . . . jacks and strips . . . standard panels . . . terminal blocks . . . mounting frames . . . plug-in chassis . . . relay racks . . . and power supplies.

Write for Complete Catalog

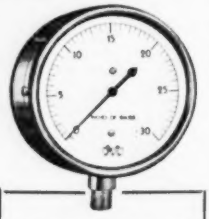
N. Y. Stock:
Audio & Video Products Corp. 730 Fifth Avenue, PLaza 7-3091

CINEMA ENGINEERING COMPANY
1510 WEST VERDUGO AVENUE, BURBANK, CALIFORNIA

Export Agents: Frazar & Hanson, Ltd. • 301 Clay St. • San Francisco, Calif., U.S.A.

For more information circle **90** on inquiry card.

MARSHALLTOWN LOW PRESSURE DIAPHRAGM GAUGE



Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking the low pressures.

Write for details and price.

LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15"—0-30"—0-60"—0-100"—0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3¼" and 4½" dial sizes mounted in black enameled deep steel case.

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN, IOWA

For more information circle **91** on inquiry card.

OPEN-HEARTH

Continued from page 1878

Discussion

From an operating point of view, it is likely that the most important findings of this study are in Figs. 5 and 6, showing heat time as influenced by air temperature, and air temperature as influenced by air leakage. They show that air temperature is a principal determiner of heat time. This leads to sustained respect for the usefulness of the flame-temperature definition which states explicitly that flame temperature is a function of heat brought to the system by air—and such heat is determined by air temperature.

The hopeless prospects for steelmaking at the lower limit of combustion-air temperature have been well known, but not much attention has been given to the upper limit, possibly because a given design and set of operating conditions impose a sort of natural limit. However, Fig. 5 suggests that the fastest heats would have been still faster with higher air temperature.

Other Factors Are Important

As an extreme case, air hot enough to melt steel with no hearth fuel could be assumed. Other than the fact that this would demand convection heating, this might not be wholly absurd, because from a refractories point of view, a one-way furnace equipped with stoves would have certain attractions. Needless to say, the principal usefulness of this trifling speculation is to emphasize the fact that potential improvement of open-hearth performance depends on factors in addition to air temperature, such as (1) utilization of fuel, (2) refractories, and (3) furnace design. So far as the first item is concerned, the flame-temperature definition implies that fuels producing heat in least volume of combustion product are best. The other important item—flame emissivity—must be high, a fact well appreciated by many operators.

So far as the second item is concerned, prospects for a revolutionary—and cheap—substance appear dim. If so, this means a rather precise upper limit to permissible air temperature, determined by the resistance of checker brick to the destructive efforts of temperature and iron oxide. Since that temperature can be exceeded at times today, the problem devolves to getting all checkers up to limiting temperature.

The third item is something else again: The open hearth of today is unmistakably the pure-blood descendent of its

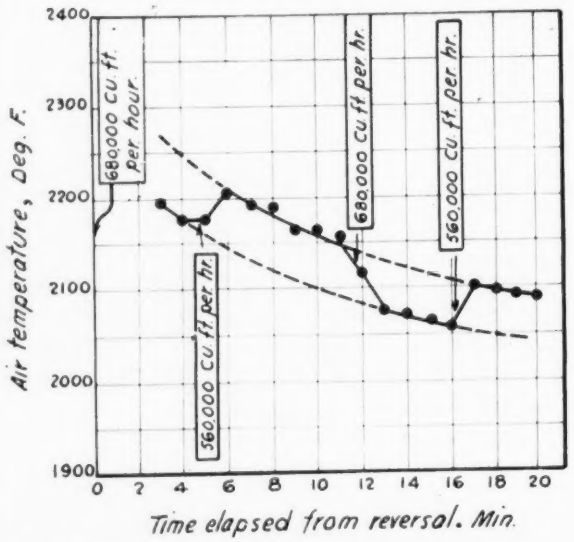
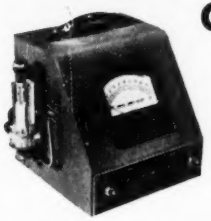


Fig. 8. Effect of increased primary air flow on air temperature.

SAVE FUEL DOLLARS

WITH A

THERMCO PORTABLE FLUE GAS ANALYZER



A COMPLETE CO^2 READING TAKES ONLY 20 SECONDS

. . . as easy as tuning in a radio!

Valuable man-hours, too, are saved by the Thermco Analyzer! CONTINUOUS READINGS . . . indicated by an accurate meter which instantly reflects flue gas changes . . . permit maintenance personnel to quickly adjust burners for proper combustion. One portable, self-contained instrument can be used to maintain a proper fuel setting for almost any number of heating units.

Send Today!

. . . for complete facts on how to save **fuel dollars** and **maintenance man-hours!**

THERMCO **LABORATORIES**
JOHNSON ROAD
MICHIGAN CITY, INDIANA

For more information circle **92** on inquiry card.

PACKAGED CIRCUITRY*

The Walkirt Co. manufactures a line of units for measuring time intervals, or highly repetitive activities up to 3 megacycles per second. Other units, also available from stock, will readily accomplish such functions as time sequential switching, pulse delaying, gating, amplifying, and pulse shaping.

Write for Catalog • Write our Engineering Service Department for specialized applications.

TYPE: M 1243

DELAY MULTIVIBRATOR

The Walkirt Type M 1243 Delay Multivibrator is one of several stock delay units providing an externally variable delay pulse.

Freq. Range: 0-10 KC (higher speed units available) • Input: 75 V negative pulses (available from Walkirt counters) • Output: 120 V peak to peak, nominal 25 microseconds delay • Diameter: Only 1 1/4 inches.

Immediate!: Available in Quantity

**Now Available Resin Encapsulated or "Open" Construction. Your Circuits Economically Packaged.*

THE **WALKIRT** CO.
145 WEST HAZEL ST., INGLEWOOD 3, CALIF.

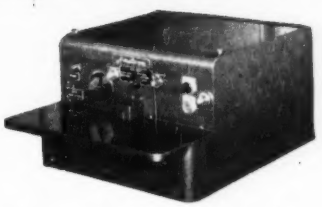
For more information circle **94** on inquiry card.

The new Ametron

ANALOG DATA RECORDER

simplifies exact measurement and numerical printing of many Analog quantities

TEMPERATURE • WEIGHT • PRESSURE • VOLTAGE • LIGHT INTENSITY • CURRENT • PH CONCENTRATION • RESISTANCE • R.P.M. • STRESS-STRAIN • DISTANCE • ANGLE DISPLACEMENT • Plus Many Others



The versatile Analog Data Recorder provides visual or printed records of virtually any physical quantity converted into a corresponding voltage through various functionally operated sensing devices—thermocouples, photocells, tachometer generators, etc. Prints accurate numerical quantity in full figures on tape, tickets or cards.

Write for new brochure AN-13

STANDARD OF ACCURACY SINCE 1888
STREETER-AMET COMPANY
4101 N. RAVENSWOOD AVENUE • CHICAGO 13, ILLINOIS
Branches in Pittsburgh, Pa., Allentown, Pa. and Birmingham, Ala.

For more information circle **93** on inquiry card.

Your kind of . . .

Solenoid Valves

There *IS* something better in solenoid valves—the new Marsh Electrimatic. Bodies machined from solid brass stock mean extra strength, greater dependability. Coils are moisture and frost proof. Valves are tight seating, smooth, positive, quiet. Types for wide range of application: direct acting—or pilot operated for large capacity.

. . . Outline your conditions and we will tell you how we can help you with your Solenoid problems.

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corp.
DEPT. 42, SKOKIE, ILL.
Export Dept., Skokie, Illinois

For more information circle **95** on inquiry card.

INTERNATIONAL RECTIFIER CORPORATION
EL SEGUNDO CALIFORNIA

Selenium Photo-Cells

UNMOUNTED CELLS

6 cell sizes.
15 to 750 micro-amperes at 100 ft.-candles illumination.

WRITE FOR BULLETIN PC-649

HERMETICALLY SEALED

DP-2 (shown above) 25 microamperes*
DP-3 — 50 microamperes*
DP-5 — 600 microamperes*
*At 100 ft.-candles illumination

INTERNATIONAL RECTIFIER
CORPORATION
1521 E. Grand Ave., El Segundo, Calif. Phone: ORegon 8-3778
CHICAGO 205 W. Wacker Drive Phone: Franklin 2-3889
NEW YORK 501 Madison Avenue Phone: Plaza 5-8665

For more information circle 96 on inquiry card.

REDUCING VALVES

No. 700 illustrated — Water pressure reducing 300 lb. initial to 50 lbs. delivery. Spring-diaphragm type for noiseless, dead end service. Large flow passages. Tight closing. Designed for maintenance without removal from line. Compact. Dependable. Other types available. GET BULLETIN 148.

Call Your Supply House or See Classified Phone Directories for Nearest KLIPFEL Agent.

Alabama Birmingham	Illinois Chicago	Missouri St. Louis Kansas City	Ohio Cincinnati Cleveland	Tennessee Memphis Nashville Knoxville
Arizona Phoenix	Indiana Evansville Indianapolis	Montana Billings	Oklahoma Tulsa	Utah Salt Lake City
California San Francisco Los Angeles	Louisiana New Orleans	New York Buffalo New York Syracuse	Oregon Portland	Washington Spokane
Colorado Denver	Massachusetts Boston	New Mexico Albuquerque	Pennsylvania Pittsburgh Philadelphia	Seattle
Florida Tampa	Michigan Detroit	North Carolina Greensboro	Texas Dallas	Wisconsin Milwaukee
Georgia Atlanta	Minnesota Minneapolis			Canada Montreal

K-941

Klipfel VALVES, INC.
HAMILTON, OHIO

For more information circle 97 on inquiry card.

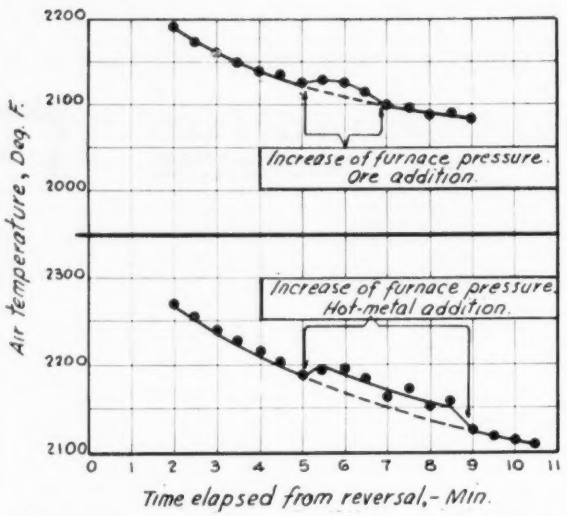


Fig. 9. Effect of furnace-pressure variation caused by ore and hot-metal addition on air temperature.

Trenton ancestor of 1868, noteworthy for its elaborately contrived obstructions to free flow of gases—and moving gas streams are heavily disinclined to change direction. Improved checker design surely must take this into account. This is not to deny that open hearth efficiency has been improved enormously in recent years. Yet, it is highly improbable that the first general design is best. That there are possibilities in making use of the principles of fluid dynamics was demonstrated recently by Chesters[3] in England, who not only proved the validity of dynamic similarity for scale-model furnaces, but also designed a full-size furnace that is showing improved performance. Among its outstanding features are sloping uptakes and no knuckles.

Conclusion

The velocity couple proved to be an extraordinarily sensitive tool for diagnosing furnace behavior. A principal finding is that air temperature has large influence on heat time. The influence is powerful enough to nullify other factors to the extent that, on the average, heat time is inversely proportional to air temperature. For a given furnace and range of fuel input, the principal determiner of air temperature is air leakage. Thus, best performance means careful attention to the sealing of openings in the regenerator system, which extends from reversing to port. Over-excess primary air is equivalent to early leakage. An air-temperature device would be highly useful for permanent installation; its development is in progress.

Judging by operating records, most open hearth furnaces are deficient in air temperature. It appears that either operating procedure, or design, or both, are at fault. Although efficiency increase over the years attests to progress, there is more to accomplish.

Acknowledgement

The task of building velocity couples and using them was in the hands of T. B. Winkler, R. S. Miltenberger, and T. V. Wainwright, of the Research Department, Bethlehem Steel Co.

References

1. Marsh, J. S., "Operation of Oxygen-enriched Open-hearth Furnaces," Transactions, American Institute of Mechanical Engineers, Vol. 176, 1948, pp. 78-91.

2. Mullikin, H. F., "Gas-temperature Measurements and the High-Velocity Thermocouple," *Temperature, its Measurement and Control in Science and Industry*, Reinhold Publishing Corp., N. Y., 1941.

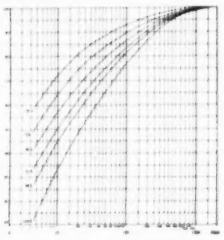
3. Chesters, J. H., Open Hearth Proceedings, American Institute of Mechanical Engineers, 1951.

"Helinews"

"Accuracy of Potentiometer Linearity Measurements"

Reprint Available

The August 1953 issue of Tele-Tech & Electronic Industries carried a significant article on the accuracy of potentiometer linearity measurements, by two members of Helipot's Research and Development staff, Robert McDonald and Irving Hogan.



Reprints are available for the asking — please write and your copy will be sent at once.

ASK FOR DATA FILE No. 1211

Helipot corporation

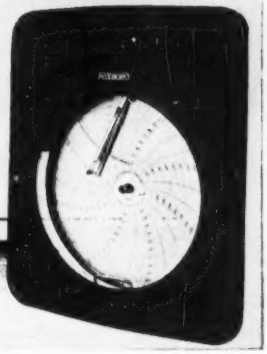
a division of BECKMAN INSTRUMENTS, INC.
SOUTH PASADENA, CALIFORNIA
...first in precision potentiometers

225

For more information circle **98** on inquiry card.

LIQUID LEVEL

Indicators
Recorders
Controllers

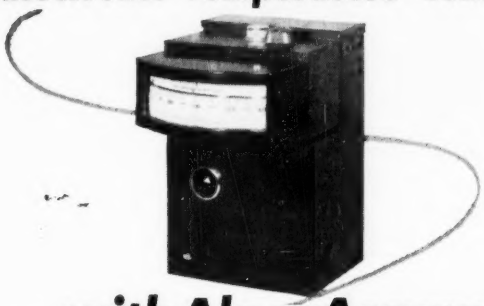


The completeness of the Foxboro Line is your assurance of *unbiased* recommendations on instruments to indicate, record, or control liquid level. Whatever type of system you require (bubble tube, differential pressure, float, diaphragm box) . . . whatever your problem (such as turbulent, viscous, or corrosive liquids, whether in open or pressured vessels) — Foxboro offers the most efficient instruments for the job. Why not consult Foxboro first — and be sure! Write The Foxboro Company, 4612 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO Instruments
REG. U.S. PAT. OFF.

For more information circle **99** on inquiry card.

Electronic Temperature Control



...with Alnor Accuracy

Alnor, pioneer in the field of electronic temperature instruments, brings you automatic, precise temperature control for heat-treating furnaces, bake ovens—in fact, for any heating device whether electrically heated or fuel fired. It's the Alnor Temperature Controller—simple in design and operation, its accuracy proved on thousands of installations in many industries.

Easily and quickly installed, this instrument is ready to give you accurate controller service on new or existing heating equipment temperature—you merely set the pointer at the desired temperature and forget your indicating and controlling problems. But find out for yourself how Alnor accuracy and dependability can serve you in controller service; write today for complete details on the Alnor Temperature Controller... Alnor accuracy at a price you can afford. Illinois Testing Laboratories, Inc., Rm. 518, 420 N. La Salle Street, Chicago 10, Illinois.

Alnor **PRECISION INSTRUMENTS FOR EVERY INDUSTRY**

For more information circle **100** on inquiry card.

new! WEKSLER Junior ADJUST-ANGLE THERMOMETER

- **QUICK-SETTING** . . . adjusts to any angle!
- **EASIER-READING** Positions to any angle through 180° arc!
- **CUTS REPLACEMENT COST** Will not break under normal shock or vibration!

Now, the 5" submarine thermometer can be obtained with the Weksler Adjust-Angle feature. The complete line covers 5", 7", 9" and 12" case sizes.

Today—find out how WEKSLER can make things smoother for you.

Write for Free Bulletin AA50.

"Industrial America's Right Arm"
WEKSLER THERMOMETER CORPORATION
Martinique Building
49 West 32nd Street • New York 1, N. Y.

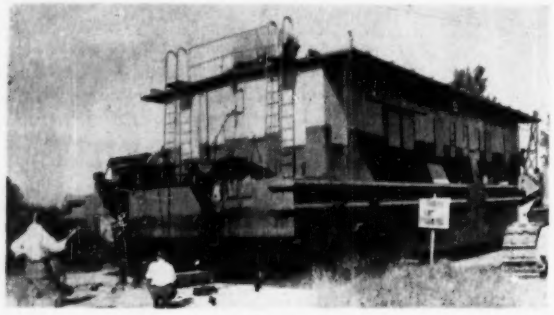
For more information circle **101** on inquiry card.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

A Dredge Is Weighed

BRIDGEPORT, N. J.—Weighing this dredge recently presented a problem that was solved readily by The Testing Equipment Department of Baldwin-Lima-Hamilton Corporation. Four Baldwin SR-4 load cells of 200,000-lb. capacity



each, smaller than the jacks used for lifting the dredge, and a portable Baldwin SR-4 load indicator were all that was needed to determine electrically the weight of 181 tons. Weight of the dredge was required as a basis for rigging charges before it could be launched at Bridgeport, N. J. by Weldon Contracting Company.

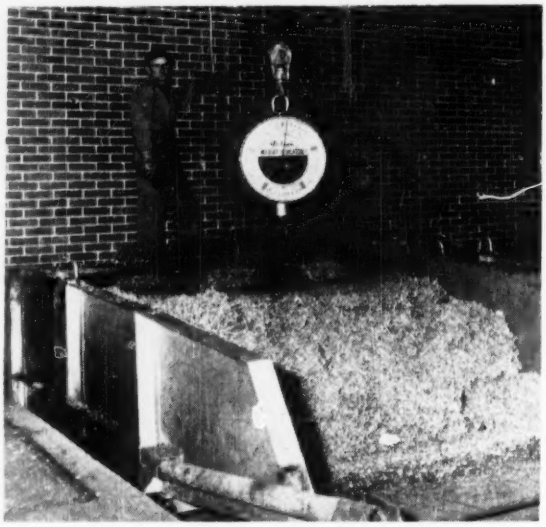
Phila. ISA Fair

PHILADELPHIA, PA.—View of the well-arranged and interesting Instrument Fair at the Elks Club, Philadelphia, October 21st. This exhibit replaced one of the regular-meeting night programs, and was one of the most successful meetings ever held by the Philadelphia Section of the Instrument Society of America.

The following companies displayed their products: Askania Regulator Co., Automatic Switch Co., Arnold O. Beckman, Inc., The Bristol Co., Brooks Rotameter Co., Conoflow Corp., Daniel Orifice Fitting Co., Davis Instruments, Thomas A. Edison, Inc., Fielden Instrument Div., Fischer and Porter Co., Fisher Governor Co., Hayes Corp., Kieley and Mueller, Inc., King Engineering Corp., Leeds & Northrup Co., Manning, Maxwell & Moore, Milton Roy Co., Mine Safety Appliance Co., Minneapolis-Honeywell Reg. Co., Moore Products Co., Linn O. Morrow & Son, Penn Industrial Instrument Corp., Photovolt Corp., Republic Flow Meters Co., Research Controls Co., Standard Instrument Corp., Taller & Cooper, Inc., Wheelco Instruments Div.

Salvage Savings

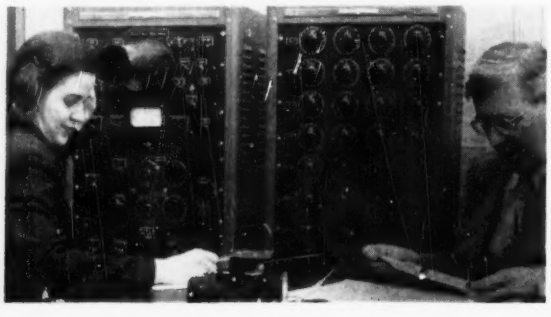
LOS ANGELES, CALIF.—The McCullough Motor Corp. of Los Angeles reports that their new disposal bin for salvaging scrap will pay for the bin and the instrumentation



in less than two years. The 92-foot dock is divided into 1-ton bins, each holding a different type of scrap. Maximum savings are assured because inferior grades are separated and the scrap is weighed. The weight indicator of 5000-pound capacity is made by W. C. Dillon & Co., Van Nuys, Calif.

Thermal Analog Computor

SCHENECTADY, N. Y.—An electronic thermal analog computer (ETAC) has been developed by General Electric's



New Product Announcement

Swartwout Autronic Type D2T Differential Pressure or Flow Transmitter

Differential Pressure Transmitter for static pressures to 5000 psig

Swartwout Type D2T transmitter is designed for use with other units of the all-electronic Swartwout Autronic Control System, the system that solves your toughest problems in remote control and/or recording of process variables.

CONDENSED SPECIFICATION DATA

MAX. WORKING PRESSURE: 1500 and 5000 psi models with full over-range protection.
BODY MATERIAL: 303 stainless steel.
DIAPHRAGM MATERIAL: 302 stainless steel or Teflon coated glass fabric. (Other body and diaphragm materials available to special order.)
RANGE: 0-20 to 0-200 inches water. Span continuously adjustable.
ZERO ADJUSTMENT: Vernier screw with lock.
COARSE SPAN ADJUSTMENT: Linkage ratio.
VERNIER SPAN ADJUSTMENT: Electrical; does not affect zero setting.
DISPLACEMENT: Less than 0.3 cc.
ACCURACY: ½%.
ULTIMATE SENSITIVITY: Better than .005%.
CALIBRATION: May be weight calibrated without removing from line.
REPRODUCIBILITY: 0.1%.
FREQUENCY RESPONSE: Flat to 8 cycles/sec.
SPEED OF RESPONSE: .02 seconds for 63.2% of full scale change.
AMBIENT TEMPERATURE EFFECT: 1% max. zero shift for 100°F temperature change.
STATIC PRESSURE EFFECT: Less than .05% per 100 psi change at 200" water span setting.
OVER-RANGE EFFECT: Less than 1% at 200" water span setting for full rated static over-range.
MAX. AMBIENT TEMPERATURE: 180°F.
CASE: Dustproof and weatherproof.
EXPLOSION PROOFING: Available. May be calibrated while in operation.

Investigate the advantage, of the Swartwout Autronic System today. Literature and prices on request to factory or from Swartwout representatives in principal cities.

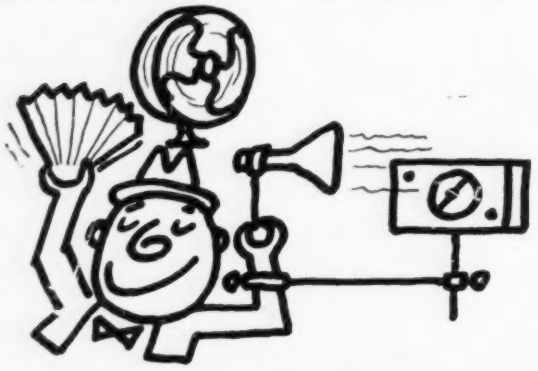
A-8013

50 YEARS Service to Industry The Swartwout Company 1903-1953

Swartwout *Autronic* **CONTROL SYSTEM**

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **102** on inquiry card.



Why dry it the hard way?

Kemp Dynamic Dryers do it cheaper, better, more easily! For as little as ¼¢ per mcf (including cost of labor, materials, capital investment), Kemp dries air, gases or liquids to sub-zero dew points. Performance to your specifications *guaranteed*. Write today for Bulletin D-29 to find out how Kemp can protect *your* valuable instruments: C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Maryland.

DYNAMIC DRYERS

KEMP OF BALTIMORE

BURNERS • CARBURETORS FIRE CHECKS • METAL MELTING UNITS • INERT GAS GENERATORS SINGEING EQUIPMENT

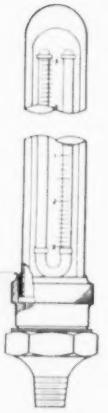
For more information circle **103** on inquiry card.

Low-Temperature Glass to Metal Seals

NEW illustrated bulletin shows how to join glass and metal at only 250°F! No special equipment required to apply Cerroseal-35 to clean glass, glazed ceramics, quartz or mica.

Also useful for metal to metal soldering where ultra low joining temperature of pre-tinned parts is required.

Cerroseal-35 affords an easy means of making connections in vacuum testing systems and in other applications where operating temperatures are relatively low.



Write today for Bulletin E-14. Working sample furnished on request.

CERRO DE PASCO CORPORATION

Dept. 18, 40 Wall Street, New York 5, N. Y.

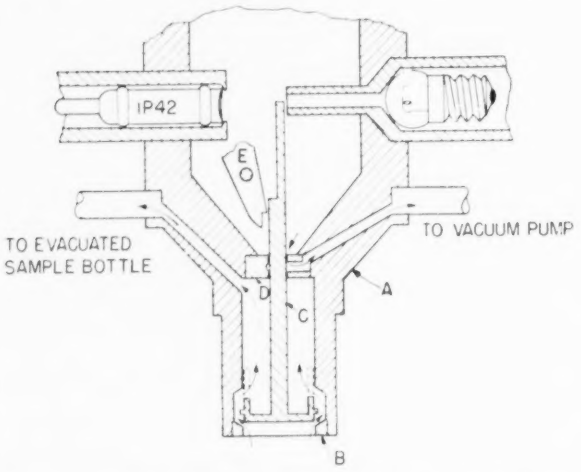
Makers of Cerrobase, Cerrobend, Cerramatrix, Cerrosafe and Cerrotru.

For more information circle **104** on inquiry cards.

Advanced Engineering Development Section to solve thermal problems in small motors at the company's Specialty Motor Sub-Department. Operating within an accuracy of three percent, the instrument solves one- to four-mesh thermal problems involving intermittent duty cycles, forced convections, and vapor cooling.

Rapid Gas Sampler

WASHINGTON, D. C.—A fast-acting mechanical device that takes samples of a rapidly changing gas over extremely short intervals—0.2 millisecond or less—has been recently developed by W. J. Levedahl of the National Bureau of Standards. The body (A) of the valve is designed to fit a ⅞-inch spark plug hole. In the initial, closed position, the lapped flange of the piston (C) is pressed against the lower seat (B) of the valve by the trigger (E). When the trigger



is released by a solenoid-operated mechanism, the pressure of the gases in the cylinder accelerates the piston upward. The cylinder gases then pass around the piston head, and continue to do so until the upper edge of the head passes the upper seat. The upper seal is complete when the flange is seated in the top position. Passage of light from the flashlight bulb (upper right) to the 1P42 photoelectric cell is cut off by the extension of the piston shaft, producing on an oscilloscope screen a square wave which indicates the time of opening and closing of the valve. During operation the entire system is evacuated to less than 0.01 mm. Hg.

Automatic Screw Machines

DETROIT, MICH.—In an address before the 1953 Annual Conference of the American Society of Tool Engineers, Julius Kaplan of the Arma Corporation brought out that tape-recording memory devices, in conjunction with feedback-controlled devices, offer a flexible and rapid means for controlling automatic screw machines and other metal-working machinery. Reprints of Mr. Kaplan's paper are available from Arma Corp., 254 36 St., Brooklyn, N. Y.

Mine Communications

WHEELING, W. VA.—The Beech Bottom Mine of the Windsor Power House Coal Co., near Wheeling, W. Va., have installed MSA "MinePhones" on the mine locomotives that operate throughout the mine. The FM voice-transmission system enables the dispatcher to remain in continuous contact with the locomotive motormen. The "MinePhones" are a development of Mine Safety Appliances Co., Pittsburgh 19, Pa.

Book Reviews

INSTRUMENT MAINTENANCE SHORT COURSE

Instruments Publishing Co., Inc., 845 Ridge Ave., Pittsburgh 12, Pa. Paper, 36 pages, $2.00.

Twelve papers presented at the Los Angeles Harbor Junior College, Applied Technology Div., in co-operation with the Southern California Meter Association; treats smoke measurement, recording calorimeter, maintenance of pressure recorders, principles of automatic control, pH measurement, computation of orifice coefficients, electronic recorders, art and science of industry instrumentation, electrolytic conductivity, gas-pressure regulation, liquid displacement meters, and gas gravitometers.

HANDBOOK OF NOISE MEASUREMENT

A. P. G. Peterson, and L. L. Beranek

General Radio Co., Cambridge 39, Mass. Paper, 102 pages plus appendix, $1.00.

Nine chapters, spiral bound, on principles, equipment, and techniques for measurement of airborne sounds.

NOMOGRAPHY AND EMPIRICAL EQUATIONS

Lee H. Johnson

John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y. 1952. 162 pages $3.75.

Nomographs and empirical formulae are two useful techniques for handling experimental and operational data. Persons unskilled in mathematics can construct nomographs and obtain rapid solutions to many otherwise time-consuming calculations. This book gives the reader a thorough treatment of the factors involved in construction of specific nomographs. Methods are shown for determining the best arrangements of scales. Techniques are given for applying nomography and curve fitting to a wide variety of problems in science and engineering.

POLAROGRAPHY

I. M. Kolthoff

Vol. 1—Theoretical Principles, Instrumentation and Technique. 2nd edition, 420 pages $9.00.
Vol. 2—Inorganic, Organic, Biological Application, Amperometric Titrations. 2nd edition, 1952. 570 pages, $11.00 Interscience Publishers, Inc., 250 5th Ave., New York 1, N. Y.

"As a comprehensive source book on instrument circuitry, this one will be hard to beat" . . . *Radio & Television News* (Sept. 1953)

ELECTRONIC CIRCUITRY FOR INSTRUMENTS & EQUIPMENT

By MILTON H. ARONSON
Technical Editor, *Instruments*

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $ ..... for ..... copies of Aronson's ELECTRONIC CIRCUITRY BOOK at $4.00 each, postpaid.

Name .....

Address .....

City .....

FOURTH

AGA product announcement in as many months.

Next month, watch for another field-tested development of even more interest

NEW!

Compact, hermetically sealed

AGASTAT
trademark

TIME DELAY RELAYS

2⅛" square, 4" high. Weighs 1.2 lbs.

The SF AGASTAT is a solenoid operated, pneumatically-controlled time delay relay. It is hermetically sealed in an enclosure only 2⅛ inches square by 4 inches high. It weighs only 1.2 pounds.

Originally developed for aircraft use, the SF is ideal wherever control devices must operate in wet, corrosive, dusty or explosive atmospheres, and for applications involving shock, vibration or acceleration. It is not affected by freezing temperatures. Time delay range from approximately 30 milliseconds to more than one minute. Completely adjustable throughout this range.

Write for details and application engineering assistance.
Address Dept. A-10-129

AGA DIVISION

Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1935.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

PROCESS CONTROL

Combustion Control. New 40-page illustrated catalog presents features, function, description and specifications of maker's combustion-control equipment. Also treats "Robot-Eye" control for fuel/air ratio.—Standard Instrument Corp., 350 Fifth Ave., New York, N. Y.

Circle **401** on inquiry card.

Pneumatic Transmitter. New 8-page illustrated Bulletin 2553 covers design details, construction, operating characteristics, principle of operation, and applications of maker's heavy-duty pneumatic signal transmitter for use in measuring, indicating, and controlling flow and level at pressures to 1500 psi.—Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.

Circle **402** on inquiry card.

Centralized Process Instrumentation. New 4-page illustrated Bulletin 109 presents features and dimensions of maker's miniature control-board instruments (Mini-Line) such as remote manual relays, selector valves, multipoint indicators, and vertical-scale indicators.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **403** on inquiry card.

Process Instrumentation. New 3rd-quarter issue of "Instrumentation" discusses instrumentation of pressurized blast furnaces, btu controller, chlorine feeder system, principles of optics, automatic amperometric titration and carbon-black production.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **404** on inquiry card.

Pneumatic Control. New 4-page illustrated Bulletins 768 and 771 present principles, characteristics, specifications, and operation of maker's three-mode "Tel-O-Set" pneumatic controllers.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **405** on inquiry card.

Contact Meter-Relay Control. New 4-page Bulletin G-5 presents description, features, and circuit diagram of maker's automatic contact meter relay with electro-magnetic locking contacts on D'Arsonval movement.—Assembly Products, Inc., Main at Bell Sts., Chagrin Falls, Ohio.

Circle **406** on inquiry card.

Transmission Lags. New 28-page issue, Vol. 6, No. 2 of "Technology" feaures article on effects of transmission lags on controllability. Other articles cover applications of maker's instruments to paper pulp manufacture, fire water main control, brewing, felt, and dairy industries.—Taylor Instruments Cos., Rochester 1, N. Y.

Circle **407** on inquiry card.

Combustion Control. New 4-page Bulletin C-101 describes and illustrates maker's automatic combustion control for oil, gas, or coal fired boilers.—Reliance Instrument Manufacturing Corp., 190 Glen Cove Ave., Glen Cove, L.I., N. Y.

Circle **408** on inquiry card.

VALVES

Cylinder Valve Actuators. New 4-page Bulletin 3000 describes and illustrates maker's pneumatic and hydraulic cylinder-type valve actuators for standard valves.—Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles, Calif.

Circle **409** on inquiry card.

Safety Valves. New 4-page condensed catalog and price list describes and illustrates maker's safety devices for steam and hot-water boilers and tanks.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago, Ill.

Circle **410** on inquiry card.

Control Valves. New 10-page Bulletin LB-1-20M describes and illustrates maker's "Conomotor Series LB" control valves.—Conoflow Corp., Phila. 3, Pa.

Circle **411** on inquiry card.

Regulating Valves. New 2-page Bulletin BBC 1 describes and illustrates maker's type "BBC" pressure reducing and regulating valve.—A.W. Cash Valve Mfg. Corp., 666 E. Wabash Ave., Decatur, Ill.

Circle **412** on inquiry card.

Miniature Solenoid Valve. New 2-page Bulletin 529 describes and illustrates maker's "V10" Series" miniature high-pressure solenoid-operated hydraulic valves.—Skinner Electric Valve Div., Edgewood Ave., New Britain, Conn.

Circle **413** on inquiry card.

Solenoid Multiport Valves. New 8-page Bulletin SK-53 describes and illustrates maker's "Speed King" solenoid and pilot operated control-valve said to have a life of over twenty million cycles.—Valvair Corp., Akron 11, Ohio.

Circle **414** on inquiry card.

TEMPERATURE

Thermocouple Calibration Data. New 12-page Bulletin P1259 has 8 pages of tables based on data recently released by The National Bureau of Standards, adopted by SAMA and ISA, and corrected to the absolute volt and to the International Temperature Scale of 1948. Also described are maker's program controllers and potentiometer pyrometers.—The Bristol Co., Waterbury, Conn.

Circle **415** on inquiry card.

Hand Pyrometer. New 4-page illustrated Bulletin GEA-6020 gives uses, features, specifications, and accessories for maker's portable hand pyrometer for measuring temperature of any surface, gas, liquid, or molten metal from 0 to 1500 degrees F.—General Electric, Schnectady 5, N. Y.

Circle **416** on inquiry card.

Temperature Control. New 2-page illustrated Bulletin 101 presents purpose, operation, construction, and specifications of maker's high temperature controls that use differential-expansion members to operate switches.—Burling Instrument Co., 5 Vose Ave., S. Orange, N. J.

Circle **417** on inquiry card.

Thermistors. New Bulletins (TH-9, Th-10, and Th-11) present methods of using thermistors—heat sensitive resistors with negative temperature coefficient. Bulletin PM-116 describes new physical demonstration of permanent-magnet properties.—Carboloy Dept., General Electric, Detroit 32, Mich.

Circle **418** on inquiry card.

Pyrometer Conversion Kit. New 4-page brochure describes maker's kits for converting mechanical pyrometers into electronic instruments.—Pyrometer Service Co., 348 River Rd., N. Arlington, N. J.

Circle **419** on inquiry card.

Temperature Controller. New 12-page illustrated Bulletin P-811 gives description, typical applications, principle of operation, specifications, and accessories of maker's new "Model 077" electronic temperature controller.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **420** on inquiry card.

Dial Thermometers. Two new 2-page bulletins describe and illustrate maker's mercury-actuated "multi-angle" dial thermometer and "miniature" mercury dial thermometer.—United States Gauge, Div. of American Machine & Metals, Inc., Sellersville, Pa.

Circle **421** on inquiry card.

Pyrometer Wire, Thermocouple Heads. New 4-page illustrated bulle-

tin gives features of maker's plastic-sheathed pyrometer wires and new rust-proof light-weight thermocouple head.—Industrial Pyrometer & Supply Co., Alton, Ill.

Circle **422** on inquiry card.

Thermometer Specifications. New 2-page bulletin presents "Recommended Specifications for Fractional-degree Thermometers" and general laboratory centigrade, fahrenheit, and double-scale thermometers.—Scientific Apparatus Makers Assoc., 20 N. Wacker Dr., Chicago, Ill.

Circle **423** on inquiry card.

PRESSURE

Pitot Tubes. New 8-page Bulletin 51 presents principles, construction, application, installation, calculation, and diagrams of maker's pitot tubes. —Meriam Instrument Co., 10920 Madison Ave., Cleveland, Ohio.

Circle **424** on inquiry card.

Manometers. New 4-page bulletin illustrates and describes maker's line of U-tube, well-type and absolute-pressure manometers and flowmeters. Data Sheet 70 describes complete line of tank gauges.—Trimount Instrument Co., 3119 W. Lake St., Chicago, Ill.

Circle **425** on inquiry card.

Pressure, Flow Control. New 66-page illustrated Catalog 2 describes maker's line of small valves, pressure regulators, stainless-steel cylinders, flo-gages, and oxy-gas torches.—Hoke, Inc., 231 S. Dean St., Englewood, N. J.

Circle **426** on inquiry card.

Pressure Transducer. New 2-page Tentative Data Sheet E-53-02 X gives application and specifications of maker's new "Model EQL" water-cooled high-frequency pressure transducer that uses catenary diaphragm and tubular strain gages.—Control Engineering Corp., 560 Providence Highway, Norwood, Mass.

Circle **427** on inquiry card.

Pressure Switch. New 2-page and 4-page bulletins describe features, specifications, and circuit diagram of maker's Bourdon-tube-type pressure switch.—Simple Mfg. Corp., Syracuse, N. Y.

Circle **428** on inquiry card.

Pressure Switch. New 2-page bulletin gives construction, features, and diagrams of maker's multi-range pressure switch.—Alloy Bellows Engineering Co., 18125 Roseland Rd., Cleveland, Ohio.

Circle **429** on inquiry card.

Transducers for Pressure, Motion. New 8-page catalog gives features and specifications of maker's new line of transducers. Includes linear and angular measurement types; pressure transducers of gage, differential, and absolute types; linear accelerometers of modulated carrier and velocity types, angular accelerometers, and strain gages.—Sweeney Engineering Corp., 3825 Willat Ave., Culver City, Calif.

Circle **430** on inquiry card.

FLOW

Flow Meters. New 28-page illustrated Catalog 2300 presents explanation of flow cost accounting, flow system components, characteristics of maker's flow meters, and electronic recorders and integrators. Includes principles of square-root extraction and installation details.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **431** on inquiry card.

Flow Controllers. New 8-page illustrated Bulletin 470 presents principles, operation, specifications and diagram of maker's "Model 59" valve-mounted controller for fast-response flow control with use of d/p cell.—Foxboro Co., Foxboro, Mass.

Circle **432** on inquiry card.

Flow Measurement. New 8-page Bulletin 52-1017-37 presents principles, applications, operation, and features of maker's "Diaflow" meters. —Hays Corp., Michigan City, Ind.

Circle **433** on inquiry card.

Flow Transmitter. New 4-page Bulletin 2653 presents combination of 1500-psi. liquid line-flow measuring element and pneumatic flow-signal transmitter, including principles and design.—Hagan Corp., Pittsburgh 30, Pa.

Circle **434** on inquiry card.

Rotameters, Pumps. New 4-page issue of "Shutte & Koerting Engineering News" (Vol. 5, No. 3) describes and illustrates maker's rotameters, pumps, and other products.—Shutte and Koerting Co., 18 State Rd. Cornwells Heights, Bucks County, Pa.

Circle **435** on inquiry card.

Controlled-volume Pumps. New 12-page Technical Paper 57 deals with design and operation of controlled-volume chemical feed pumps.—Sta. H, Milton Roy Co., 1300 E. Mermaid Lane, Phila., Pa.

Circle **436** on inquiry card.

Gravimetric Feeder. New 4-page Bulletin 3288 describes and illustrates maker's weigh feeder for injection-molding machines.—Exact Weight Scale Co., Columbus 8, Ohio.

Circle **437** on inquiry card.

Filter Pumps. New 8-page brochure describes filter and pump equipment

INSTRUMENT & CONTROL CONSULTANTS

Engineering Services, Testing Laboratories and other Professional Services

Engineering, design, procurement and supervision of the installation of all instrumentation and engineered control equipment, specializing in the designing and building of complete coordinated controls for industrial processes.

We will be glad to discuss your process control problems with you. Why not give us a call?

EQUIPMENT & CONTROLS ENGINEERS Inc.

814 Noblestown Road — Box 4446

Pittsburgh 5, Pa. — WAlnut 1-1615

For more information circle **106** on inquiry card.

BLAW-KNOX **CHEMICAL PLANTS DIVISION**

BLAW-KNOX COMPANY

PITTSBURGH 22, PENNSYLVANIA

Consultation, design and installation of control systems

For more information circle **107** on inquiry card.

Consult Design Construct

Instrumentation and automatic control for industry

cdc Control Services INCORPORATED

cdc

For more information circle **108** on inquiry card.

C.O.M.S.I.P.

Specialized in control Engineering

Instrument layout—Procurement—Application—conventional and graphic panel design and construction

INSTALLATION—REVAMPING

STARTING UP—MAINTENANCE

40 Ave. Verdun • Croissy • S&O France

For more information circle **109** on inquiry card.

HOLLADAY & WESTCOTT

5384 Huntington Drive

Los Angeles 32, California

DESIGN ENGINEERING for ENVIRONMENTAL TEST EQUIPMENT

Low Temperature Specialists

For more information circle **110** on inquiry card.

Aviation Power Process

DELAWARE VALLEY ENGINEERING CO.

EVergreen 2-5952

3326 Lancaster Ave. Phila. 4, Pa.

A. C. Arobone J. E. Cline E. C. Smith

For more information circle **111** on inquiry card.

for electroplating and industrial solutions.—Sethco Mfg. Co., 70 Willoughby St., Brooklyn, N. Y.

Circle **438** on inquiry card.

LEVEL

Liquid Level Control. New 24-page Bulletin 2000A presents features, applications, dimensions and construction of maker's liquid level controllers, float valves, and balanced lever valves.—Kieley & Mueller, Inc., North Bergen, N. J.

Circle **439** on inquiry card.

Level, Density, Interface. New 4-page bulletin describes and gives applications of level, density, and interface gauges based on maker's radioactivity detector.—The Ohmart Corp., 2236 Bogen St., Cincinnati, Ohio.

Circle **440** on inquiry card.

WEIGHT, FORCE

Precision Scales. New 4-page illustrated Bulletin 3277 describes maker's line of scales with 75-pound capacity of "Shadowgraph" (electrical) and mechanical types. 2-page Bulletin gives features and specifications of maker's general industrial scales.—Exact Weight Scale Co., Columbus 8, Ohio.

Circle **441** on inquiry card.

FOR ALL-AROUND LABORATORY WORK
there are no finer
presses than WABASH
● Models from 3 Ton to 50
Precision construction, sturdiness, convenience and dependability are reasons for the popularity of Wabash hydraulic laboratory presses. With such quality features as chrome plated columns . . . precision bored guide holes . . . parallel platens sturdy hydraulic jacks and many others, they are outstanding in quality—yet reasonably priced.
USE THEM FOR . . .
Plastic forming, molding
Extrusion Tests
Laminating
Card & Badge Laminating
Vulcanizing
Transoptic Specimen mounting
Briquetting
Pressing out oils, waxes, etc.
Embossing
Compression testing
Drawing and Forming
Dehydrating
Breaking Tests
Crushing Tests
Spring Testing
Adhesive testing
Liquid-Solid Separation
Pressure filtering
Juice, sap extraction
Vaccines, vires pressing
The NEW 30 Ton Model
WRITE TODAY TO . . .
WABASH METAL PRODUCTS CO.
WABASH, INDIANA
For more information circle **112** on inquiry card.

Platform Weighing Scale. New 4-page illustrated Catalog 10 lists features, specifications, typical applications, capacities and dimensions of maker's new pneumatic weighing scale for batch or continuous process weighing.—Weighing Components, Inc., 64 Fulmor Rd., Hatboro, Pa.

Circle **442** on inquiry card.

Dynamometer. New 2-page bulletin describes and illustrates maker's precision dynamometer for determining delicate-mechanism actuating force as in relays, switches.—George Scherr Co., Inc., 200 Lafayette St., New York, N. Y.

Circle **443** on inquiry card.

VIBRATION, ACCELERATION

Vibration Detector. New 4-page illustrated bulletin describes principles of operation and applications of maker's "Elec-Detec" electronic test instrument for locating mechanical troubles in equipment by audio-video stethoscope.—ANCO Instrument Div., American Name Plate & Mfg. Co., 4254 W. Arthington St., Chicago, Ill.

Circle **444** on inquiry card.

Accelerometer Requirements. New 2-page Bulletin IB-4 outlines pertinent questions to aid in the choice of proper accelerometers and associated equipment.—Gulton Mfg. Corp., Metuchen, N. J.

Circle **445** on inquiry card.

SURFACE ROUGHNESS

Surface Roughness. New 4-page Bulletin ED-21702 describes and illustrates maker's new "Surfindicator" surface-roughness indicator.—Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.

Circle **446** on inquiry card.

Profilometer Amplimeter. New 2-page Bulletin LT87 describes and illustrates maker's profilometer "Type QA" amplimeter for measuring surface roughness.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **447** on inquiry card.

GAGES, COMPARATORS

Plug Gages. New 4-page Catalog C-53 describes and illustrates maker's plain and thread reversible plug gages, AGD thread ring gages and setting plugs.—Size Control Co., 2500 W. Washington Blvd., Chicago, Ill.

Circle **448** on inquiry card.

Gages, Comparators. New 36-page illustrated Catalog Sec. 3-F covers maker's line of micrometers, height gages, comparators, depth gages, etc. —DoAll Co., Des Plaines, Ill.

Circle **449** on inquiry card.

Micrometers, Calipers. New 4-page bulletin describes and illustrates maker's micrometers, vernier calipers, "mage-blox," and radius dresser.—George Scherr Co., Inc., 200 Lafayette St., New York, N. Y.

Circle **450** on inquiry card.

Optical Comparator. New 8-page Bulletin 55-10M-1053 describes and illustrates maker's "AO" optical projection comparator.—Optical Gaging Products, Inc., 26 Forbes St., Rochester, N. Y.

Circle **451** on inquiry card.

TESTING

Creep-testing Machine. New 2-page illustrated Bulletin 10.18-5 describes operation and instrumentation of new "Arcweld" lever-arm creep-testing machine for special-alloy high-temperature steels.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **452** on inquiry card.

Universal Testing Machine. New 8-page Bulletin 4206 describes and illustrates maker's 50,000-pound-capacity universal testing machine.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **453** on inquiry card.

Non-destructive Test Instruments. New 8-page Bulletin 32 describes and illustrates maker's non-destructive and physical testing and measuring instruments for quality control.—using ultrasonic, magnetic, and non-magnetic techniques. Covers maker's "Cyclograph," "Metroscope," "Megotron," "Dynagage," etc.—J. W. Dice Co., Englewood, N. J.

Circle **454** on inquiry card.

Nondestructive Testing. New 4-page Bulletin 16.701 gives uses, method of operation, range and calibration, theory, and power requirements of maker's "Magnatest" electronic nondestructive testing instrument for nonmagnetic metals, which uses conductivity eddy-current technique.—Magnaflux Corp., 7300 W. Lawrence Ave., Chicago, Ill.

Circle **455** on inquiry card.

Extensometers. New 18-page booklet describes and illustrates maker's extensometer strain gages, accessories, and specialties.—F. F. Metzger & Son, 2600 N. 6 St., Phila. 33, Pa.

Circle **456** on inquiry card.

Brake Testing Recorder. New 2-page pamphlet 627aE presents technical data, construction, principle, and description of distributor's Askania Brake Testing Recorder.—European Products Importing Co., Inc., 154 Nassau St., New York, N. Y.

Circle **457** on inquiry card.

RECORDING

Potentiometer Recorders. New 48-page illustrated Catalog 1520 describes maker's line of "Electronik" recorders and indicators, including basic principles of the continuous balance unit, circular chart and strip chart recorders, precision indicators, primary-measuring-elements, analytical apparatus, and measuring circuits. —Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **458** on inquiry card.

Recording Oscillographs, Stress. New 24-page Catalog CGC-301 to 307 and 3040 describes maker's "408 and 409" oscillograph, "Model 201" galvanometer, "Model 1809" bridge control unit, and "Models 507 and 508" vibration and stress analysis amplifiers. Also includes specifications and characteristics of maker's vibration and stress analysis system.—Century Geophysical Corp., 1333 N. Utica, Tulsa, Okla.

Circle **459** on inquiry card.

Recording Oscillograph. New 10-page bulletin describes and illustrates maker's new low-cost dynamic-data-recording 6-channel miniature oscillograph "Model 5-117."—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **460** on inquiry card.

Curve Follower. New 4-page bulletin describes and illustrates maker's "TI GEDA" transducer that automatically follows curve drawn in pencil to generate functions, and which also serves as X-Y function plotter.—Goodyear Aircraft Corp., Akron 15, Ohio.

Circle **461** on inquiry card.

Electronic Potentiometer. New 4-page illustrated bulletin presents features, applications, specifications, and diagram of maker's "Model P-2" precision electronic potentiometer for electro-chemical and electronic applications.—Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston, Texas.

Circle **462** on inquiry card.

Recording Oscillograph. New 4-page Bulletin 107-8-53 presents features of maker's "Type-J" recording oscillograph plus attachments.—William Miller Instruments Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **463** on inquiry card.

Foundry Recording Instruments. New 4-page illustrated Bulletin 753 describes maker's graphic recording instruments for achieving correct mixtures of sand for foundry molds and cores.—Esterline-Angus Co., Inc. P.O. Box 596, Indianapolis, Ind.

Circle **464** on inquiry card.

Tape Recorder. New 2-page bulletin describes and illustrates maker's portable magnetic-tape recorder and player.—Telectroscopic Corp., 35-18 37 St., Long Island City, N. Y.

Circle **465** on inquiry card.

LAB APPARATUS

Laboratory Glassware. New 4-page illustrated Bulletin F-231 gives features of Pyrex laboratory glassware for hospitals, clinical research, and health labs.—Burrell Corp., 2223 5th Ave., Pittsburgh, Pa.

Circle **466** on inquiry card.

Laboratory Equipment. New 20-page "Eberbach Announcer" (No. 53-10-52) describes and illustrates universal stirrer, wedge interference filter, microscopes, balances, and other lab equipment.—Eberbach & Son Co., Ann Arbor, Mich.

Circle **467** on inquiry card.

MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED

STANDARD

MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

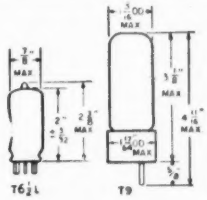
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

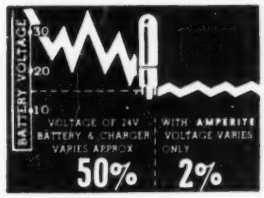
TYPES: Standard Radio Octal, and 9-Pin Miniature.

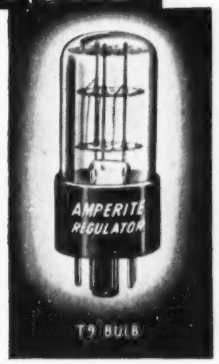
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.







Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto 2B

For more information circle **113** on inquiry card.

TWENTY TIMES *tested*

Texas Instruments transistors are in production and available in the five basic types shown below . . with custom-built units also available. An exhaustive testing program—combined with precise manufacture to instrument standards—insures the maximum reliability in these transistors.

Every TI transistor must pass more than 20 test procedures — in addition to continual visual checks — before it is granted the TI trademark and shipped to the user. Glass-to-metal hermetic sealing provides maximum moisture protection.

The five Texas Instruments transistor types include both junction and point-contact designs. TI transistors can be used in audio amplifiers, audio and radio frequency oscillators, low and high speed electronic switching circuits, multi-vibrators and pulse circuits, and other circuits where miniaturization is desirable.

A MAJOR OPPORTUNITY FOR MINIATURIZATION IN DESIGN • A MAJOR OPPORTUNITY FOR MINIATURIZATION IN DESIGN •

OF SPECIAL INTEREST to electronic design engineers are TI transistor bulletins with sections on theory and application. Formulae, equivalent circuits, and characteristic curves are given, along with hints on installation and operation. Write for your copies today!

Transistors in actual size

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVE DALLAS 9, TEXAS

For more information circle **114** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Electrophoresis-Diffusion Instrument. New 8-page illustrated Bulletin 8H853 gives design, optical system, and specifications of maker's "Model H" electrophoresis-diffusion instrument for analysis and identification of electrically-active particles in biology and chemistry.—Specialized Instruments Corp., Belmont, Calif.

Circle **468** on inquiry card.

Microtome. New 4-page bulletin describes and illustrates maker's fiber microtome. Includes information on maker's other products—engraver's, grinders, coil winders, etc.—Micro Instrument Co., 80 Trowbridge St., Cambridge, Mass.

Circle **469** on inquiry card.

Laboratory Mill. New 4-page bulletin describes and illustrates maker's laboratory mill that applies shock to liquids and suspensions by directing it against teeth of rotating circular saw.—Rafton Engineering Corp., 16 Haverhill St., Andover, Mass.

Circle **470** on inquiry card.

Analytical, Vacuum Balances. New 4-page illustrated Bulletin CB8/35M presents design, operation, maintenance and specifications of maker's "Selecta" balances. Pamphlet CB/18 covers Sartorius vacuum balance.—C. A. Brinkmann & Co., Great Neck, N. Y.

Circle **471** on inquiry card.

Refractometer. New 1-page brochure gives description and features of "Bellingham & Stanley" industrial refractometer "Model 52."—C. A. Brinkmann & Co., P. O. Box 532, Great Neck, N. Y.

Circle **472** on inquiry card.

Resin Viscosity Control. New 8-page Bulletin O-103 describes use of Benthal in production of short and medium oil aklyd resins to control viscosity until desired acid number is obtained. Lists typical formulations—Monsanto Chemical Co., Organic Chemicals Div., St. Louis 4, Mo.

Circle **473** on inquiry card.

Petroleum Testing Apparatus. New 2-page Bulletin 100-A describes and illustrates maker's grease pressure viscometer, oil oxidation and other petroleum testing apparatus.—Technical Equipment Co., 743 Dwight Way, Berkeley, Calif.

Circle **474** on inquiry card.

Microtome. New 1-page bulletin presents description and general data on maker's custom produced high speed microtome for cutting thin cross sections suitable for electron microscopy, including brittle metals.—Princeton Technical Products Co., P. O. Box 384, Princeton, N. J.

Circle **475** on inquiry card.

ANALYTICAL

Mass Spectrometer. New 12-page illustrated Bulletin GEC-587A gives component parts, operational procedures, range, resolution, system specifications, and applications of maker's new mass spectrometer for chemical analysis by mass separation.—General Electric, Schenectady 5, N. Y.

Circle **476** on inquiry card.

Spectrography, Microscopy. New 16-page issue of "Norelco Reporter" (Vol. 1, No. 2) features articles on microtome for sectioning in electron and light microscopy and on X-ray spectrography.—North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

Circle **477** on inquiry card.

Gas Analyzers. New 12-page illustrated Bulletin 11-10 presents features of maker's portable and continuous gas analysis instruments using catalytic combustion, thermal conductivity and electroconductivity techniques.—Davis Instruments, 47 Halleck St., Newark, N. J.

Circle **478** on inquiry card.

Plane Grating Spectrograph. New 4-page Bulletin EB-10-53 covers features, applications and specifications of maker's Ebert 3.4-meter plane-grating spectrograph.—Jarrell-Ash Co., Farwell St., Newtonville, Mass.

Circle **479** on inquiry card.

Spectrochemical Analysis. New 4-page bulletin describes and illustrates maker's "Spec-lab," a complete packaged spectrochemical laboratory.—Jarrell-Ash Co., Newtonville, Mass.

Circle **480** on inquiry card.

Save time

ENGRAVE

in your own shop

Lowest set-up time for unskilled labor

CALIBRATIONS

PROFILES

CURVED SURFACES

10,000 in use. The speediest, most versatile portable engraver. Only the NEW HERMES has these features:

• Adjustable for 15 ratios. • Self-centering holding vise. • Automatic depth regulator. • Adjustable copy holders.

Send direct to us for booklet IM 37

NEW HERMES ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N. Y.

For more information circle **115** on inquiry card.

OPTICAL

Photometer. New 4-page illustrated Bulletin 10.10-4 gives application, equipment, and operation of "Gardner" automatic photometric unit using maker's amplifier and balancing motor.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **481** on inquiry card.

Photoprocessor, Spectrograph. New 4-page Bulletin P-8-53 describes and illustrates maker's photoprocessor for films and plates. Companion bulletin describes and illustrates maker's 3.4-meter stigmatic grating spectrograph.—Jarrell-Ash Co., Newtonville, Mass.

Circle **482** on inquiry card.

Colorimeter. New 4-page illustrated Bulletin 144 gives features and operational procedure for maker's automatic tristimulus colorimeter with three revolving scales.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **483** on inquiry card.

Magnifier. New 2-page bulletin describes and illustrates maker's 2X self-focusing magnifier glass for reading.—J. B. Sebreil Corp., 300 S. Los Angeles St., Los Angeles, Calif.

Circle **484** on inquiry card.

RADIOACTIVITY

Radiation Detection. New 62-page Catalog 15 is complete catalog of maker's electronic equipment, radiation counter tubes, glass apparatus, and radiation-detection equipment.—Radiation Counter Laboratories, Inc., 5122 W. Grove St., Skokie, Ill.

Circle **485** on inquiry card.

Fast Neutron Counters. New 2-page bulletin describes and illustrates maker's fast-neutron counters. Includes specifications.—Radioactive Products Inc., 443 W. Congress, Detroit, Mich.

Circle **486** on inquiry card.

TIME

Stop Watches, Chronographs. New 12-page bulletin describes and illustrates maker's stop watches and chronographs with non-breakable coil-spring mechanism.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

Circle **487** on inquiry card.

Industrial Timepieces. New 12-page Catalog 153 describes and illustrates maker's stopwatches for industrial time and motion studies.—M. Ducommun Co., 1 West 47th St., New York, N. Y.

Circle **488** on inquiry card.

COMPUTING, COUNTING

Analog Computer. New 2-page illustrated Bulletin 103-9-53 presents purpose, components, and uses for maker's "Milac" analog computer and analog computing service.—William Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **489** on inquiry card.

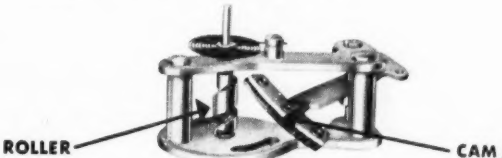
Try a HELICOID. Find the toughest spot you have for a gage. Let the HELICOID prove itself. Let it show you how much these quality gages can save you, especially in maintenance, as the standard gage throughout your plant.

HELICOID has no gears to wear out!

Flutter, extreme surges, rapid pulsations—these break down ordinary gages but they can't hurt a HELICOID because 1) the HELICOID has no gears, no teeth to wear out; 2) the cam releases from roller at maximum dial graduation (it resets automatically, instantly). See illustration below.

Many Sizes, Many Styles

You can get HELICOID Gages for pressure, vacuum, or compound service—in all pressure ranges; white, black or radiant faces; wall, stem, flush, and panel mountings, for flangeless cases. See your distributor today or write for **catalog G-2.**



Only HELICOID offers this long-lasting gearless gage movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

927 Connecticut Avenue • Bridgeport 2, Connecticut

HELICOID
Pressure
•
Vacuum
GAGES

For more information circle **116** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Digipot, Digicon. New 2-page bulletin describes and illus rates maker's mechanical counter with potentiometers or contacts on each of the wheels for remote counting, telemetering, servos, computers, etc.—Wright Engineering Co., 180 E. California St., Pasadena, Calif.

Circle **490** on inquiry card.

Ballistic Film Analyzer. New 2-page bulletin gives features and components of maker's "Boscar Model A" ballistic film analyzer and recorder that uses projector and optics for rapid position measurement in cartesian coordinates.—Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles, Calif.

Circle **491** on inquiry card.

Data Reduction. New 2-page illustrated bulletin presents features, speed, operation and results from maker's "Oscar" data-reduction system for analog-to-digital conversion and application of nonlinear calibrations.—Benson Lehner Corp., 2340 Sawtelle Blvd., West Los Angeles, Calif.

Circle **492** on inquiry card.

Analog Computer. New 64-page issue of "General Electric Review," (Vol. 56, No. 6) features article on analog computers and others on engineering education, microwave radio, etc.—General Electric Co., Schenectady 5, N. Y.

Circle **493** on inquiry card.

Ferro-resonant ting Elements. Three new 2-page tins give features and applicatio f maker's ferro-resonant ring ele nts for counting, low-impedance power supplies, and dynamic cry tal diode tester.—Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.

Circle **494** on inquiry card.

Electromechanical Integrator. New 4-page bulletin presents description, principles of operation, and specifications of maker's integrator for integrating curves and analyzing data. —Instron Engineering Corp., Quincy 71, Mass.

Circle **495** on inquiry card.

Punched-card Computer. New 8-page illustrated Brochure TM 842 presents features, applications, and operation of maker's new electronic punched card computer.—Remington Rand Inc., 315 Fourth Ave., New York, N. Y.

Circle **496** on inquiry card.

Coun ing Devices. New 4-page Condensed Catalog describes maker's counting devices for mechanical and hand operation, pre-determining, electrical and textile counters.—Veeder-Root Inc., Hartford 2, Conn.

Circle **497** on inquiry card.

Electronic Counters, Controls, Relays. New 4-page illustrated Catalog 453 describes maker's predetermined, reset, and electronic counters, liquid-level and photo-electric controls, and pilot relays.—Haledy Electronics Co., 57 William St., New York, N. Y.

Circle **498** on inquiry card.

AUDIO, RADIO, TV

Hi-Fi Sound. New 60-page illustrated 1954 Catalog features distributor's line of high-fidelity sound equipment such as tuners, amplifiers, record changers, speakers, phonograph cartridges, tape recorders, and TV chassis.—Hudson Radio & Television Corp., 48 W. 48 St., New York, N. Y.

Circle **499** on inquiry card.

Audio, Radio, TV Buying Guide. New 24-page Bulletin 136 describes and illustrates audio, radio, and TV equipment available from distributor. —Allied Radio, 100 N. Western Ave., Chicago 80, Ill.

Circle **500** on inquiry card.

Industrial TV. New 8-page Bulletin 2J8837 describes and illustrates maker's closed-circuit industrial-television system and explains camera, monitor, and installation.—Industrial Products Sec., RCA, Camden 2, N. J.

Circle **501** on inquiry card.

MAGNETICS

Magnet Use Ideas. New 18-page Brochure PM-102 (in kit form) gives

DC-AC CHOPPERS
Triple Certified
FOR MILITARY USE
0 — 500 CPS
1. Each lot is sample life tested to prove 1000 hours life —55°C., +85°C.
2. Every Chopper is given two complete operating tests —55°C., +25°C., +85°C. This is double-proof of stamina. Nothing left to chance.
3. Gold contacts are used exclusively in order to obtain superior results in the vital 0–1½ volt d-c range.
All the usual military specifications are met and there are liberal factors of safety to meet emergency conditions.
Write for information.
Catalog 280C — 0–500 cps
Catalog 246E — 60 cps
STEVENS
INCORPORATED
ARNOLD
22 ELKINS STREET
SO. BOSTON 27, MASS.

For more information circle **117** on inquiry card.

DO IT YOURSELF
with the
GREEN ENGRAVER
Fact-filled folder on request . . . showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.
Routs Models
Profiles Engraves
Etching attachment and other special equipment for industrial uses are available.
Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . . easily, simply, quickly . . . tracing from a master with the GREEN ENGRAVER.
Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed. The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass.
Green Instrument Co.
INCORPORATED
383 PUTNAM AVE., CAMBRIDGE, MASS.

For more information circle **118** on inquiry card.

applications, general information, and practical hints for industrial use of permanent magnets. Receivers of kit will get future idea releases.—Carboloy Dept., General Electric Co., Detroit 32, Mich.

Circle **502** on inquiry card.

Permanent Magnets. New 6-page illustrated Bulletin PM-111 gives uses, design, properties and manufacture of Alnico permanent magnets, sintered grade 5. Includes charts, graphs, and photomicrographs in explanation of magnetic and physical characteristics. —General Electric, Carboloy Dept., Detroit 32, Mich.

Circle **503** on inquiry card.

Laminations. New 24-page Bulletin L-752 describes and illustrates maker's electrical laminations. Includes specifications and prices.—Thomas & Skinner Steel Products Co., Indianapolis, Ind.

Circle **504** on inquiry card.

Magnetometer. New 2-page bulletin describes and illustrates maker's new "Model D1-M" magnetometer for reconnaissance and general prospecting. —The Radiac Co., Inc., 489 Fifth Ave., New York, N. Y.

Circle **505** on inquiry card.

Magnetic Amplifiers. New 2-page Bulletin 501-8-53 lists features and applications of maker's new 400-cycle 5-watt-output gain-of-20 magnetic amplifier.—Transformer Engineers, 161 E. California St., Pasadena, Calif.

Circle **506** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Electric Testing Instruments. New 16-page illustrated Bulletin Gea-5469B "Buyer's Guide for Testing Instruments" presents features and specifications for maker's large line of test instruments—hook-on volt-ammeters, wattmeters, power-factor meters, portable recorders, voltmeters, ammeters, etc.—General Electric, Schenectady 5, N. Y.

Circle **507** on inquiry card.

Plug-in Units. New 12-page Catalog C-3 describes, illustrates, and gives applications and advantages of maker's plug-in units for various basic circuits—amplifiers, oscillators, gates, cathode followers, flip-flops, delays, etc.—Electronic Engineering Co., 180 S. Alvarado St., Los Angeles, Calif.

Circle **508** on inquiry card.

VTVM. New 4-page illustrated Bulletin R-1-A presents features, description, specifications and basic circuit arrangement of maker's "Model R-1" DC and AC VTVM with 65 ranges and modes of operation.—Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston, Texas.

Circle **509** on inquiry card.

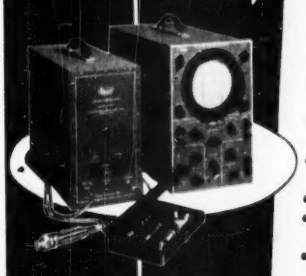
Watertight Panel Instruments. New 2-page Bulletins 112 and 120 illustrate and describe maker's 1½-inch round (Model 120) and square (Model

FOR DYNAMIC PRESSURES

NO OTHER Pressure-Measuring Device COMPARES with

Electro ELECTRONIC EQUIPMENT Pressuregraph

Here's why



- Measures dynamic pressures.
- Drift stabilized.
- Temperature stabilized.
- Linear output for unit pressure change.
- One pick-up for all pressures.
- Balanced output for driving DC recorders.
- No need for pre-amplifiers to drive recorders or oscillographs.
- Simple operation.
- Records pressure transients as short as 50 micro-seconds.
- Can be water-cooled for temperatures exceeding 1000° F.
- Auxiliary Synchro-Marker adds 2 channels (timing and positioning) on pressure curve.
- Up to 200 feet of pick-up cable can be used.
- Flush-head type pick-up available . . . stops cavity effects.
- Auxiliary pick-up standard assures correct adjustment for all diaphragms.
- Time proved by internationally known industrial concerns, universities and research laboratories.
- Reasonably priced.

Bulletin listing varied applications and specifications on request.

EPL Field Engineers Throughout the Country Available to Help Solve Your Pressure Problems.

ELECTRO PRODUCTS LABORATORIES

4501-Ip Ravenswood Ave., Chicago 40, Ill. • *Canada:* Atlas Radio Corp., Ltd., Toronto, Ont.

For more information circle **119** on inquiry card.

If you use pyrometers, you need

THERMOCOUPLE EXTENSION WIRES

THERMO ELECTRIC extension wires utilize the most advanced synthetic insulations — they maintain accuracy by protecting wires from moisture, petroleum products, and most other chemicals, even after extensive use at temperatures as high as 600°F. This means longer service for wires, less replacement cost for you.

Industry, whether it be aircraft, chemicals, petroleum, plastics, metals, or any other field that requires accurate temperature measurement, profits from our experience and complete wire-making facilities. Our plant handles all phases of wire-making and thus maintains uniformly high quality. Standard wires are shipped from stock, special orders are produced promptly.

GET DETAILED DATA; WRITE FOR BULLETIN 31 -F TODAY.

Thermo Electric Co., Inc.

FAIR LAWN NEW JERSEY

For more information circle **120** on inquiry card.

For Eye-Level Readings...

AUTO-LITE

...TEMPERATURE INDICATION

3-way adjustable mounting

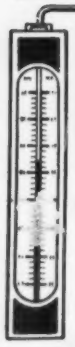
Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F to plus 750°F. Send for latest catalog showing various types.

Model F-1 temperature indicator—Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $22.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE INDICATORS & RECORDERS

For more information circle **121** on inquiry card.



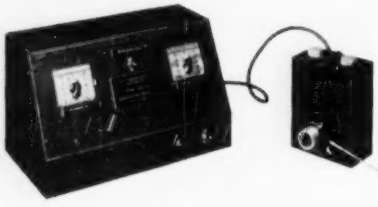
TANK-O-METER
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

HYDROSTATIC GAUGES
FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
BAROMETRIC PRESSURE
DIFFERENTIAL PRESSURE
SEND FOR BULLETINS

UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

For more information circle **122** on inquiry card.



The Instrument with 1001 Applications

New & Improved PHOENIX
Line Operated
ELECTRON MULTIPLIER PHOTOMETER

For precise measurement of low light values down to 12 micro-microlumens. Will operate 5MV recorder or laboratory type galvanometer.

Phoenix Precision Instrument Co.
3803 N. 5th St., Philadelphia 40, Pa.

For more information circle **123** on inquiry card.

NEW LITERATURE

112) watertight panel instruments.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **510** on inquiry card.

Bridge Measurements. New 8-page "General Radio Experimenter" (Vol. 28, No. 5), features articles on adaptors for coaxial transmission lines, and bridge measurements for laboratories.—General Radio Co., Cambridge, Mass.

Circle **511** on inquiry card.

Inverter-Amplifier. New 2-page Bulletins 205 and 305 treat maker's inverter-amplifiers of high-gain preamplifier type for cathode-ray oscillographs and tape recorders, and low-drift d-c. amplifier for galvanometer oscillographs.—Allegany Instrument Co., 1000 Oldtown Rd., Cumberland, Md.

Circle **512** on inquiry card.

Dual-beam CRO. New 4-page Bulletin 102-9-53 presents features, applications, and description of maker's "Model L" dual-beam cathode-ray oscillograph.—William Miller Instruments Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **513** on inquiry card.

Electrostatic Voltmeters. New 8-page issue of "Electrical Measurements" (Vol. 20, No. 9) features articles on maker's electrostatic voltmeters, peak-voltage measurements, and pivot errors in panel meters.—Sensitive Research Instrument Corp., 9-11 Elm St., Mount Vernon, N. Y.

Circle **514** on inquiry card.

Electronic Test Equipment. New 4-page issue of "Hewlett-Packard Journal," Index of volumes 1 to 4, chronologically indexes literature anent maker's electronic test equipment and their applications.—Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.

Circle **515** on inquiry card.

Electronic Surveying. New 4-page bulletin describes and illustrates maker's electronic surveying equipment that uses radar beacon technique.—Moran Instrument Corp., 170 East Orange Ave., Pasadena, Calif.

Circle **516** on inquiry card.

Carrier Terminal Circuits. New 12-page issue of "Lenkurt Demodulator" (Vol. 2, No. 11) features article on d-c. terminal circuits for carrier-telegraph systems plus articles related to radio and telegraph carrier systems for multi-channel communications.—Lenkurt Electric Co., San Carlos, Calif.

Circle **517** on inquiry card.

Amplifier, Generator. Two 2-page bulletins describe and illustrate maker's "Model 33A and 33B" ten-cycle amplifier, and maker's "Model 43A" square-wave generator.—Electro-Mechanical Research, Inc., Ridgefield, Conn.

Circle **518** on inquiry card.

Oscilloscope Kits. New 8-page bulletin presents features of maker's kits for oscilloscopes, grid dip meter, battery eliminator, generator, transformer, voltmeter, wattmeter, etc.—Heath Co., Benton Harbor, Mich.

Circle **519** on inquiry card.

Circuit Resonance Indicator. New 1-page Bulletin presents maker's new low-cost circuit-resonance indicator for HF, VHF, and UHF.—Dynamic Electronics, Inc., 73-39 Woodhaven Blvd., L. I., N. Y.

Circle **520** on inquiry card.

Microwave Impedance. New 8-page issue of "PRD Reports" (Vol. 2, No. 3) presents methods and techniques devised to obtain greater accuracy with slotted sections of precision microwave measuring instruments.—Polytechnic Research & Development Co., 55 Johnson St., Brooklyn, N. Y.

Circle **521** on inquiry card.

Electronic Test Equipment. New Bulletins TO-100, DT-100, PC100, and PG-200A present features and construction of maker's push-button test oscillator, germanium diode tester, pulse generator and calibrator, and wide-range fast-pulse generator, respectively.—Teletronics Lab., Inc., 54 Kinkel St., Westbury, L. I., N. Y.

Circle **522** on inquiry card.

Audiosweep Generator. New 4-page bulletin describes and illustrates maker's "Model AB" audiosweep generator.—Technomatic Instrument Co., 2316 Pico Blvd., Santa Monica, Calif.

Circle **523** on inquiry card.

Large-screen Oscilloscope. New 4-page bulletin describes and illustrates maker's "Model 21A" large-screen oscilloscope using a 21-inch rectangular tube.—Technomatic Instrument Co., 2316 Pico Blvd., Santa Monica, Calif.

Circle **524** on inquiry card.

UHF Oscillator. New 4-page bulletin describes and illustrates maker's UHF wide-band power oscillator.—W. L. Maxon Corp., 460 West 34 St., New York, N. Y.

Circle **525** on inquiry card.

Program Equalizer. New 2-page Bulletin E describes and illustrates maker's "Type 4201" program equalizer.—Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

Circle **526** on inquiry card.

Diode Test Set. New 2-page bulletin describes and illustrates maker's "Model D102" diode test set.—Electronics Production Service Co., 871 Washington St., Canton, Mass.

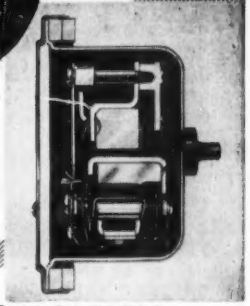
Circle **527** on inquiry card.

Meg-ohm-voltmeter. New 2-page bulletin describes and illustrates maker's "Model 640" meg-ohm voltmeter for insulation, resistance, continuity, and voltage testing.—All Mail Sales Co., 100 Park Place, New York, N. Y.

Circle **528** on inquiry card.

Burlington

RUGGEDIZED
HERMETICALLY SEALED
INSTRUMENTS



LABORATORY APPROVED
Under MILITARY SPECIFICATION MIL-M-10304

- Will withstand Hi-Impact Shock Tests, extensive vibration and tumbling requirements, extreme thermal shock, humidity and temperature tests.
- Glass to metal type seal with molded vulcanized rubber terminal connections capable of carrying 30 amps for self-contained units.
- Magnetically shielded.
- Black satin onodized aluminum bezel.
- D'Arsonval permanent magnet type movement—for all D. C. Ranges.
- Available in 2½" and 3½" round case types.
- Guaranteed one year against defective workmanship and materials.

BURLINGTON INSTRUMENTS ALSO AVAILABLE IN HERMETICALLY SEALED OR BAKELITE CASES IN 1½" THROUGH 4½" SIZES.

BURLINGTON INSTRUMENT COMPANY
DEPT. H-123, BURLINGTON, IOWA

For more information circle **124** on inquiry card.

ONLY THE Servoscope®

HAS ALL THESE FEATURES

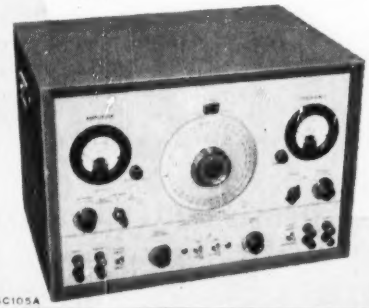
applicable to both AC carrier and DC servo systems

built-in low frequency sine wave generator for obtaining frequency response of DC servo systems

built-in electronic sweep with no sweep potentiometer to wear out and require replacement

dynamic frequency control range of 200 to 1

SERVOSCOPE is a versatile, time-saving test instrument for use in the development of all types of Servo-mechanisms and Process Controls.



SC105A

Write for bulletin giving complete specifications

SERVO CORPORATION OF AMERICA
NEW HYDE PARK, NEW YORK

For more information circle **125** on inquiry card.

schaevitz engineering

ROTARY ACCELERATOR

The following are standard or optional features that can be supplied:

ELECTRONIC CONTROLLER—furnishes speed ranges to 1900 RPM with very precise speed control. Acceleration ranges 0-1000 G. Dynamic braking on all models.

ROTATING TEST ARMS—various types interchangeable to suit test objects as large as a 16 inch cube and up to 100 pounds in weight.

SLIP RINGS—all are coin silver faced with three silver graphite brushes per ring and up to 24 rings per spindle. Instrument rings with shielded leads rated for 5 amperes at 110 volts; power rings rated for 20 amperes at 280 volts.

OPTICAL SYSTEM—has wide field and large depth of focus so that rotating objects may be viewed as if stationary.

PRESSURE AND VACUUM SYSTEM—up to four lines to the rotating arm of all models.

SAFETY GUARD—of heavy steel on all models for safety of personnel.

CONTROLS—centralized in a control console remote from the machine.

TACHOMETER AND RPM PICKUP—Tachometer generator and meter provide continuous speed measurement accurate to 2%. For extreme accuracy a pickup is provided for use with stroboscopic frequency measuring equipment.

BALANCING—rotary arm is easily removable for balancing or for mechanical modification.

CASTERS—for mobility on some models.

These and other features can readily be furnished in many combinations to fill your test needs. Ask for specification sheet No. E-1-1 for data on standard models, or inquire about your special requirements.

SCHAEVITZ ENGINEERING

P.O. Box 505 **CAMDEN 1, NEW JERSEY**

For more information circle **126** on inquiry card.

Over 85% of the torque wrenches used in industry are
STURTEVANT
TORQUE WRENCHES
Read by Sight, Sound or Feel.
● Permanently Accurate
● Practically Indestructible
● Faster—Easier to use
● Automatic Release
● All Capacities
in inch ounces . . . inch pounds . . . foot pounds
(All Sizes from 0-6000 ft. lbs.)
STURTEVANT TORQUE MANUAL
Every manufacturer, design and production man should have this valuable data. Sent upon request.
P.A. STURTEVANT CO.

For more information circle **127** on inquiry card.

High Precision Optical Components Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane Mirrors

•

Plane Parallel Plates

•

Schlieren Systems

•

Wind Tunnel Optics

•

Lenses & Prisms of Glass Natural or Synthetic Crystals

•

Complete Optical and Mechanical Instruments

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co.

3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **128** on inquiry card.

NEW LITERATURE

POWER SUPPLIES

Power Supplies, Microwave Instruments. New 68-page Catalog 530 describes and illustrates maker's power supplies, microwave test equipment, and TV test equipment.—Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn, N. Y.

Circle **529** on inquiry card.

Power Supply, Demodulator Unit. New 2-page Bulletin VF describes and illustrates maker's "Type VFDD" power supply and demodulator unit, for flight-test instrumentation, which excites transducers and demodulates signals for recorders.—Doelcam Corp., Soldiers Field Rd., Boston 35, Mass.

Circle **530** on inquiry card.

Dynamometer Supplies. New 28-page illustrated Catalog 753 covers features, construction, and specifications of maker's dynamotor power supplies.—Carter Motor Co., 2644 N. Maplewood Ave., Chicago, Ill.

Circle **531** on inquiry card.

Regulated Power Supplies. New 16-page and 4-page bulletins describe and illustrate maker's regulated d-c. power supplies. Includes 16 models.—Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Circle **532** on inquiry card.

High-voltage Power Supplies. New 5-page bulletin gives features, applications, and specifications of maker's bench and carrier-type high-voltage (RF) power supplies.—Neutronic Assocs., 83-56 Victor Ave., Elmhurst, L. I., N. Y.

Circle **533** on inquiry card.

ROTARY EQUIPMENT

Rotary Electric Equipment. New 15-page Catalog 153 describes maker's miniature rotary electric motors, some with centrifugal blowers, including d-c. and gear-reduction types. Write on company letterhead.—Mission Western Engineers, Inc., 132 W. Colorado Blvd., Pasadena, Calif.

Circle **534** on inquiry card.

Synchros, Servo Motors. New 8-page illustrated bulletin lists typical characteristics of maker's line of synchro resolvers, receivers, control transformers and transmitters, induction motors, and servo motors.—Ketay Mfg. Corp., 555 Broadway, New York, N. Y.

Circle **535** on inquiry card.

Balancing Motor. New 2-page illustrated Data Sheet 10.20-2b describes maker's fractional-horsepower two-phase reversible balancing motor with various geared speed ratings for 60-cycle operation.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **536** on inquiry card.

Speed Changers. New 2-page illustrated Bulletin 10 & 11 describes fea-

tures, applications, and table of ratios for maker's bantam-size speed reducers.—Metron Instrument Co., 432 Lincoln St., Denver, Colo.

Circle **537** on inquiry card.

Motors, Relays, Electronic Components. New 24-page catalog "This Month" lists distributor's line of radio and electronic parts and components—motors, servos, relays, counters, resistors, solenoid valves, etc..—Herbach & Rademan Inc., 1204 Arch St., Phila. Pa.

Circle **538** on inquiry card.

Adjustable-Speed-Drive Motor. New 12-page illustrated Bulletin D-2102 presents features, applications, and drive characteristics of maker's V°S Jr. ¾- to 3-hp. adjustable-speed-drive motor.—Reliance Electric and Engineering Co., 1076 Ivanhoe Rd., Cleveland, Ohio.

Circle **539** on inquiry card.

Motor Control. New 120-page illustrated Handy Catalog, sixth edition, describes maker's line of motor controls—relays, contactors, switches, regulators, starters, etc.—Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.

Circle **540** on inquiry card.

ELECTRONIC COMPONENTS

Electronic Components Catalog. New 196-page illustrated Catalog 56 describes distributor's line of audio, radio, television, recording equipment, and industrial and laboratory electronic testing apparatus.—Newark Electric Co., 223 W. Madison St., Chicago, Ill.

Circle **541** on inquiry card.

Electronic Components. New 20-page illustrated Catalog 973 covers maker's capacitor's insulators, bushings, tube sockets, inductors, and other electronic equipment.—E. F. Johnson Co., Waseca, Minn.

Circle **542** on inquiry card.

SWITCHES, RELAYS

Time Switches. New 24-page illustrated Bulletin GEA-5965 covers selection, application, description, features, and specifications of maker's time switches.—General Electric, Schenectady 5, N. Y.

Circle **543** on inquiry card.

Line, Slide Switches. New 16-page illustrated Bulletin RC-9B presents features, ratings and diagrams of maker's line and slide switches.—Stackpole Carbon Co., St. Marys, Pa.

Circle **544** on inquiry card.

Impulse Switch. New 2-page bulletin describes and illustrates maker's one-way impulse switch said to eliminate interlocking switches and actuating dogs.—Electro-Snap Switch and Manufacturing Co., 4220 W. Lake St., Chicago, Ill.

Circle **545** on inquiry card.

When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

Send for Bulletin DD-150

2366

Industrol CORPORATION

SUBSIDIARY OF
TRINITY EQUIPMENT CORPORATION
494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle **129** on inquiry card.

Rack up substantial savings

With user-designed test rack sockets

Now you can test subminiature tubes in octal test rack sockets! The Sylvania subminiature tube adaptor plugs into a standard octal socket. This unique test adaptor features a movable locking ring which assures excellent lead-to-contact union.

Sylvania now manufactures a complete line of test rack sockets designed especially for production testing of radio tubes. These sockets are available for 7- and 9-pin miniature tubes and octal tubes. Made of general-purpose phenolic: insulator and contacts are ruggedly constructed to withstand many tube insertions and withdrawals. For complete details write: Sylvania Electric Products Inc., Dept.3A-4212, 1740 Broadway, New York 19, N. Y.

SYLVANIA

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St., Montreal, P. Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION

For more information circle **130** on inquiry card.

Electronic Circuitry for Instruments and Equipment

By MILTON H. ARONSON
Technical Editor, *Instruments*

The first book of its kind

A Complete home-study TEXT and COURSE, with 458 multiple-choice home-study test items on basic electronic circuitry for instruments, communications, TV, laboratory apparatus, and military equipment. (Printed serially in *Instruments* as "Instrument Electronics.")

Cloth, viii + 310 pages; 5¼ x 8¼ inches; 215 illustrations; 458 test items; 10 tables; comprehensive index.

$4.00 Postpaid
(Payment must accompany order)

Instruments Publishing Co
845 Ridge Ave., Pittsburgh 12, Pa.

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of Aronson's ELECTRONIC CIRCUITRY BOOK at $4.00 each, postpaid.

Name .....

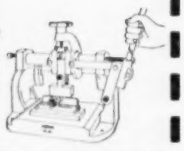
Address .....

City .....

ACROMARK

MACHINES for NUMBERING and MARKING

"The most complete line of machines and tools for marking in America."



Equipment for marking and stamping, embossing, printing and stenciling methods. Steel type, stamps, numbering and marking machines carried in stock.

Model HN Numbering Machines (hand style)—all numbers on each wheel.

HERCULES HOLDERS and Shoulder Style Steel type for numbering.

ACROMARKER Name Plate Stamping Machines are made in several models and sizes for hand and foot operation.

Write for latest illustrated literature

The ACROMARK Company

3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

Circle **132** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

•

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway
Jamaica 35, N. Y.

Circle **133** on inquiry card.

NEW LITERATURE

Mercury Relays, Thermoregulators. New 2-page bulletin and new 12-page Catalog 12 describe and illustrate maker's mercury plunger relays, thermoregulators, thermostats, glass apparatus, temperature alarms, etc. based on mercury relays and contacts in mercury-filled capillary.—Philadelphia Scientific Glass Co., Abington, Pa.

Circle **546** on inquiry card.

Switches. New 2-page data sheets 64a, 66, 68a, 71, P74, and P75 cover maker's low-force switch with lever actuator, high-precision roller-plunger switches, double-pole double-throw switch, subminiature magnetic blowout switch, and one-way actuation switches.—Micro Div., Minneapolis-Honeywell, Freeport, Ill.

Circle **547** on inquiry card.

Toggle Switches. New Preliminary Data Sheets P72, P81, P82, and P83 give features of maker's two-pole three-hole mounting, 4-pole double-throw, 3-pole double-throw, and 2-pole panel-mounting toggle switches respectively.—Micro Div., Minneapolis-Honeywell, Freeport, Ill.

Circle **548** on inquiry card.

Mercury Switches, Sequence Controllers. New set of bulletins describe and illustrate maker's metallic mercury switches (Bulletins 327 and 405) and time cycle controllers for sequence timing of electric-circuit operations (Bulletins 337 and 405).—Electric Switch Corp., Columbus, Ind.

Circle **549** on inquiry card.

Telephone-type Relays. New 12-page catalog describes maker's line of hermetically sealed telephone-type relays. Includes personnel and equipment.—Mutual Industries, 1027 N. Seward St., Los Angeles, Calif.

Circle **550** on inquiry card.

Relays. New 12-page Bulletin 100 describe and illustrate maker's computer, miniature, coaxial, and communication relays.—Joseph Pollak Corp., 81 Freeport St., Boston, Mass.

Circle **551** on inquiry card.

TUBES, TRANSISTORS

Transistors, Magnetic Amplifiers. New 16-page illustrated Bulletin B6093 treats applications and operating ranges for maker's surge comparison testers, portable balancers and vibrographs, magnetic amplifiers, transistors, capacitors, relays, etc.—Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

Circle **552** on inquiry card.

Electrometer Tubes, Components. New 8-page bulletin gives description and dimensional diagrams of maker's line of electronic components such as vibrator power supplies, voltage regulators, electrometer and d-c. amplifier tubes, counter tubes, etc.—Victoreen Instrument Co., 3800 Perkins Ave., Cleveland, Ohio.

Circle **553** on inquiry card.

Rectifiers Selection Chart. New 15 by 16½ inch chart shows rating in peak inverse voltage versus maximum average forward current for rectifier, thyratron, and ignitron tubes.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle **554** on inquiry card.

Selenium Diodes. New 4-page reprint presents "Selenium Diode Applications."—International Rectifier Corp., El Segundo, Calif.

Circle **555** on inquiry card.

Selenium Rectifiers. New 4-page issue of "International Rectifier News" RN-853 features articles on selenium rectifiers for arc welders and miniature selenium rectifiers.—International Rectifier Corp., El Segundo, Calif.

Circle **556** on inquiry card.

High-vacuum Rectifier. New 4-page bulletin contains design rating charts and curves defining performance of maker's "5AW4" high-vacuum rectifier.—CBS-Hytron, Danvers, Mass.

Circle **557** on inquiry card.

Tube Sockets. New 2-page bulletins present specifications and diagrams of maker's 9-pin and 7-pin miniature UHF sockets and test sockets.—Sylvania Parts Div., Warren, Pa.

Circle **558** on inquiry card.

RESISTORS, POTS

Precision Potentiometers. New 4-page illustrated issue No. 4 of "Helinews" discusses accuracy of potentiometer linearity measurements. Also, 1-page data sheet gives features of maker's single-turn potentiometer.—Helipot Corp., Beckman Instruments Inc., S. Pasadena, Calif.

Circle **559** on inquiry card.

Rheostats. New 2-page Aug.-Sept. issue of "Ohmite News" features articles on made-to-order rheostats, corrugated ribbon resistors, switch contacts and low-wattage resistors.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.

Circle **560** on inquiry card.

Variable Attenuator. New 2-page Bulletin A describes and illustrates maker's variable attenuators.—Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

Circle **561** on inquiry card.

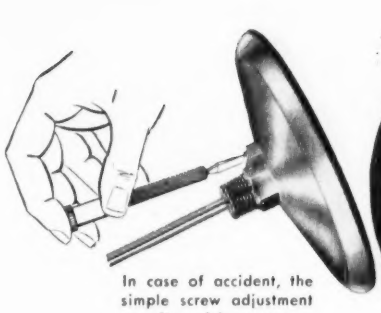
CAPACITORS

Trimmer Capacitors. New 4-page Bulletin 220 describes and illustrates maker's piston-type variable trimmer capacitors.—JFD Manufacturing Co., Inc., 1462 62nd St., Brooklyn, N. Y.

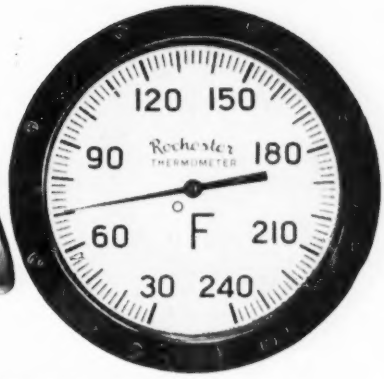
Circle **562** on inquiry card.

Capacitors. New 26-page illustrated catalog presents maker's line of hermetically sealed metal-cased capacitors.—San Fernando Electric Mfg. Co., P. O. Box 952, San Fernando, Calif.

Circle **563** on inquiry card.



In case of accident, the simple screw adjustment permits quick, easy, on-the-job recalibration.



DON'T DROP IT! BUT IF YOU DO...

ROCHESTER DIAL THERMOMETERS are built to take severe blows without damage to their sensitive movements. But when hit hard enough to knock them out of adjustment, all you need is a screwdriver to put them right back on the job—as accurate as ever. This unique Rochester recalibration feature eliminates the danger of costly production errors due to inaccurate readings.

WELDED STAINLESS STEEL construction makes Rochester thermometers more durable, sensitive, pressure tight and resistant to corrosion than any before offered. Backed by 35 years of instrument making experience.

ORDER TODAY from your Rochester Representative, or write for further details. Rochester Manufacturing Co., Inc., 85 Rockwood Street, Rochester 10, N. Y.

Rochester Manufacturing Company, Inc.
85 Rockwood St., Rochester 10, N. Y.

ROCHESTER DIFFERENTIABLE ACCURACY GAUGES

DIAL THERMOMETERS GAUGES AMMETERS

For more information circle **134** on inquiry card.

Pneumatic Weight Transmitters

FOR LINEAR CONVERSION OF WEIGHT INTO POUNDS PER SQUARE INCH AIR PRESSURE

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

WRITE FOR CATALOG

JOHN R. MONSELL
Manufacturing Engineer
Pitman, N. J.

For more information circle **135** on inquiry card.

designed for

exacting

pressure applications

HEISE GAUGES

STANDARD OF THE WORLD

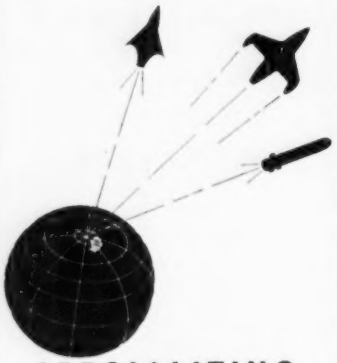
THE CHOICE of Bourdon tubes used in Heise Gauges is governed by pressure medium and pressure range. An infinite number of Bourdon tube designs is available to meet exacting requirements for accuracy and stability in many pressure media, including mercury.

There are no stock gauges. Every Heise Gauge is manufactured on special order. Ranges: 0-15 to 0-10,000 psi. Sizes: 8½", 12" and 16". Prices: $151.60 to $211.20. Gauges for use with mercury are $20.00 extra. Write for catalog.

Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

For more information circle **136** on inquiry card.

Edcliff **Precision Potentiometers**

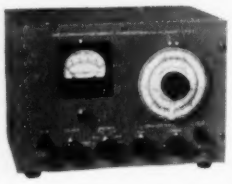


SPECIALIZING
in the design and manufacture of
LINEAR MOTION POTENTIOMETERS
and other potentiometer type instruments for measuring acceleration, pressure and position.
Ask for descriptive literature.

Edcliff *INSTRUMENTS*
383 North Foothill Blvd.
Pasadena 8, Calif.

For more information circle **137** on inquiry card.

NEW . . . PHASE MEASUREMENTS
0.1° ACCURACY
10 KC TO 10 MC
with the new precision
PHASE DETECTOR by ADVANCE
TYPE 205



Type 205 Phase Detector was developed to meet the increasing need for detecting phase angle with error of less than 0.1 degrees in high frequency communications systems such as color television.

SPECIFICATIONS

ACCURACY: ± 0.1 degree (6 minutes) in phase reading, or ± 1% of the time delay indicated on the dial of the continuously variable delay line.
FREQUENCY RANGE: 10 kc to 10 mc. The lower limit may be extended to 1 kc with an additional delay line or phase shifting network. The upper limit may be extended with relaxing accuracy.
TIME DELAY: Three variable delay lines are supplied with the unit. 0 to 0.45 microsecond, 0 to 0.25 microsecond, and 0 to 0.05 microsecond.
Continuously variable delay lines with different time delay can be obtained on request.
INDICATOR SENSITIVITY: 0.02, 0.04, 0.01, 1 and 10 volts rms.
INPUT IMPEDANCE: 1 megohm shunted with 12 uuf on both input channels.
POWER SUPPLY: 115 volts rms ± 15%, 50-60 cycles, 50 watts.

WRITE FOR DATA!

ADVANCE ELECTRONICS CO.
P. O. Box 394, Passaic, New Jersey

For more information circle **138** on inquiry card.

NEW LITERATURE

Capacitors. New 40-page illustrated Catalog 200D presents maker's line of capacitors of ceramic, electrolytic, filter, mica, paper, paper-oil, photoflash, metalized paper, and hardware type.—Cornell-Dubilier Electric Corp., 333 Hamilton Blvd., S. Plainfield, N. J.

Circle **564** on inquiry card.

TRANSFORMERS

Transformers. New 28-page illustrated Catalog TR-53 lists and gives specifications for maker's miniature and hermetically sealed transformers, power components, geophysical transformers, chokes, and television components.—Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Circle **565** on inquiry card.

Transformers. New 4-page bulletin describes and illustrates maker's custom-fitted electrical transformers.—Electrocoil Transformer Corp., Ossining, N. Y.

Circle **566** on inquiry card.

Transformers. New 30-page catalog describes and illustrates maker's large line of transformers—input, interstage, output, driver, etc.—Thermador Electrical Mfg. Co., 5119 District Blvd., Los Angeles, Calif.

Circle **567** on inquiry card.

Variable Transformers. New 18-page Bulletin 1053-5 describes and illustrates maker's "Adjust-A-Volt" variable transformers.—Standard Electrical Products Co., Dayton, Ohio.

Circle **568** on inquiry card.

Inductors. New 2-page bulletins describe and give specifications for maker's toroidal inductors and precision decade inductors.—Torocoil Co., 1374 Mobile Ct., St. Louis, Mo.

Circle **569** on inquiry card.

CONNECTORS

Miniature Connectors, Terminal Boards. Three new technical sales bulletins present description and specifications for maker's "Series FHL" (round) and "Series 18" (rectangular) miniature connectors, and "Series MT" miniature terminal board.—DeJur Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **570** on inquiry card.

Gold-plated Contacts. New 4-page issue (Vol. 6, No. 5) of "Engineering News" presents features of maker's connectors with gold-plated contacts, stacked-V antennas, etc.—American Phenolic Corp., 1830 S. 54 Ave., Chicago, Ill.

Circle **571** on inquiry card.

Audio Connectors. New 4-page illustrated Bulletin XL8-1953 gives technical information and drawings of maker's line of low-level sound connectors.—Cannon Electric Co., 3209 Humboldt St., Los Angeles, Calif.

Circle **572** on inquiry card.

Slip-ring Assemblies. New 20-page bulletin gives engineering diagrams and features of maker's slip-ring assemblies and commutators for computers, telemeters, and instruments. —Slip Ring Co. of America, 2038 Broadway, Santa Monica, Calif.

Circle **573** on inquiry card.

TUBING

Armored Tubing and Cable. New 4-page Bulletin G 91-9 gives fea ures and specifications of maker's "Armortube" cable.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **574** on inquiry card.

Armored Multitube. New 4-page Bulletin E-248 describes and illustrates maker's armored multitube protected by flexible interlocked galvanized steel armor.—Crescent Insulated Wire & Cable Co., Trenton, N. J.

Circle **575** on inquiry card.

Stainless-steel Tubing. New 8-page illustrated bulletin gives comparative analysis of alloy types, specifications, standard tolerances tables, physical properties, etc. of maker's cold-drawn mechanical, capillary, hypodermic and other stainless-steel, nickel, and alloy tubing.—J. Bishop & Co., Platinum Works, 128, Channing Ave., Malvern, Pa.

Circle **576** on inquiry card.

MATERIALS

Industrial Porcelains, Laboratory Mills. New 38-page bulletin describes and illustrates maker's line of industrial porcelains, including combustion tubes, grinding balls, protection tubes. Also described is line of laboratory jar mills.—McDanel Refractory Porcelain Co., Beaver Falls, Pa.

Circle **577** on inquiry card.

Cast Plastic Sheets. New 12-page catalog describes and illustrates aplications of maker's clear, cast thermoset "Cocor" plastic sheets.—Cast Optics Corp., Riverside, Conn.

Circle **578** on inquiry card.

High-density Alloy. New 4-page Bulletin HV-1 is a technical report on "Hevimet" alloy, a powder-metal product 50 percent heavier than lead. —Carboloy, 8 Mile Rd., Detroit 32, Mich.

Circle **579** on inquiry card.

Prefinished Metals. New 8-page illustrated Bulletin PF 264 presents maker's line of prefinished metals with modern designs, their general characteristics and properties.—Apollo Metal Works, 66th Place and S. Oak Park Ave., Chicago, Ill.

Circle **580** on inquiry card.

Copper-clad Aluminum. New 6-page Technical Bulletin 702C describes and illustrates maker's "Alcuplate" copperclad aluminum.—General Plate Division, Metals & Controls Corp., Attleboro, Mass.

Circle **581** on inquiry card.

Silicon Carbide. New 52-page Bulletin "Facts about Silicon Carbide"

6-channel unit

Measure and Record Strain with PRECISION

The Hathaway TYPE RS-10 PRECISION STRAIN INDICATOR

6, 12, 25 or 50 Channels

For Precision Measurements of Static Strain

Static strain in 1 to 50 channels can be measured in rapid succession. Individually-calibrated 21-inch dial provides an accuracy of ¼ percent. Smooth and accurate balancing controls for each channel. Continuously-variable gage-factor adjustment.

For Recording Dynamic Strain

The RS-10 can be used with an oscillograph (such as the Hathaway type S14-C) for recording dynamic strain, providing *accurate balancing* and means for *precision calibration of the records.*

MULTI-CHANNEL PRECISION MEASUREMENTS OF STATIC STRAIN

DYNAMIC STRAIN RECORDING TO 300 CPS WITHOUT AMPLIFIERS

Write for Catalog Sheet 3-H-4-L for details.

WRITE FOR YOUR FREE COPY OF HATHAWAY ENGINEERING NEWS

Hathaway INSTRUMENT COMPANY

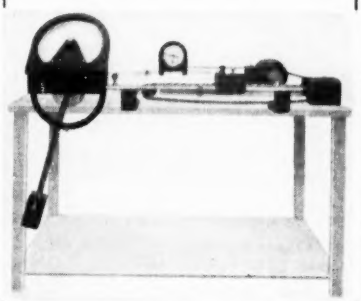
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

For more information circle **139** on inquiry card.

AMTHOR

TENSILE STRENGTH

TESTERS



type 274

for VERY LIGHT MATERIALS

Horizontal type—Bench Model

Various ranges up to maximum of 25 lbs.

With or without elongation indicator.

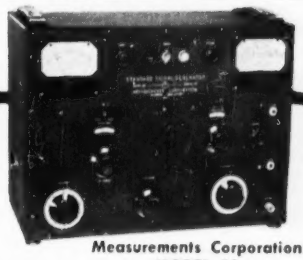
Write for bulletin 129

AMTHOR

TESTING INSTRUMENT CO., INC.

48 Van Sinderen Ave., Brooklyn, N. Y.

For more information circle **140** on inquiry card.



Measurements Corporation MODEL 82

STANDARD SIGNAL GENERATOR

20 Cycles to 50 Mc.

FREQUENCY RANGE: 20 cycles to 200 Kc. in four ranges. 80 Kc. to 50 Mc. in seven ranges.

OUTPUT VOLTAGE: 0 to 50 volts across 7500 ohms from 20 cycles to 200 Kc. 0.1 microvolt to 1 volt across 50 ohms over most of range from 80 Kc. to 50 Mc.

MODULATION: Continuously variable 0 to 50% from 20 cycles to 20 Kc.

POWER SUPPLY: 117 volts, 50/60 cycles. 75 watts.

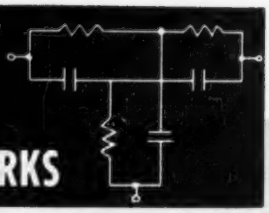
DIMENSIONS: 15" x 19" x 12". Weight, 50 lbs.

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

For more information circle **141** on inquiry card.

Stable TWIN-T REJECTION NETWORKS



For applications requiring Twin-T RC rejection or notch networks, investigate the Series 500 Filters.

- Excellent stability with time and temperature.
- Precisely adjusted null frequencies
- Optimum Q or sharpness
- Little restriction on source or load resistance
- Special as well as common null frequencies offered
- Cast in plastic for stability and ease of use

Request Bulletin 500 for full engineering information

White INSTRUMENT LABORATORIES
203 RIVERSIDE DRIVE
AUSTIN 4, TEXAS

For more information circle **142** on inquiry card.

Fine
PRESSURE GAGES . . .

—must have a high degree of accuracy. They must be built to give long service. They must be easy to maintain.

In the Acragage you get these vital necessities, plus the Solid Front with full area blow out disc. If your gages are to be used on services where pulsation is the problem, the Acragage can be equipped with the Shockstop, the pulsation dampener that cannot plug and that never has to be cleaned.

Catalog M-50 tells all about the Acragage.

Send for your copy

The ACRAGAGE Corporation

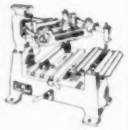
WAMPUS LANE • MILFORD, CONN.

For more information circle **143** on inquiry card.

ENGRAVING MACHINES FLOOR and BENCH MODELS

Highly efficient precision machines for engraving steel, other metals and plastics.

You're always safe in buying PREIS-*PANTO Engraving Machines and Accessories.



Write for catalog and prices.

PANTO *TRADE MARK Reg. U. S. Pat. Off.

H. P. PREIS Engraving Machine Co.
661 U. S. Highway 22 Hillside, N. J.

For more information circle **144** on inquiry card.

NEW LITERATURE

treats discovery, formation, properties, preparation, and applications of compound such as catalyst carrier, porous media, electric heating elements, resistors and deoxidizer in metallurgy of iron and steel.—Carborundum Co., Niagara Falls, N. Y.

Circle **582** on inquiry card.

Chromate Finish for Aluminum. New 8-page bulletin describes new protective treatment for aluminum. Accompanying bulletins describe application of same "Iridite" process to steel, zinc, magnesium, and cadmium. —Allied Research Products, Inc., 4004 E. Monument St., Baltimore, Md.

Circle **583** on inquiry card.

Extruded Plastics. New 12-page brochure treats applications, properties of plastics, plus custom shapes and table of thermoplastic characteristics.—Anchor Plastic Co., Inc., 36-36 36th St., Long Island City, N. Y.

Circle **584** on inquiry card.

FABRICATION, SHOP EQUIPMENT

Ultrasonic Cleaning. New 4-page illustrated Bulletin GEA-6056 treats principle, methods, and applications of maker's ultrasonic generator to high-frequency-sound cleaning.—General Electric, Schenectady 5, N. Y.

Circle **585** on inquiry card.

Soldering Iron. New 2-page Catalog Page U-10 describes and illustrates maker's miniature electric soldering irons.—Ungar Electric Tools, Inc., P. O. Box 312, Venice, Calif.

Circle **586** on inquiry card.

Engraver Master Type. New 4-page Bulletin 321 describes and illustrates maker's master type for use with engraving machine.—Green Instrument Inc., 385 Putnam Ave., Cambridge 39, Mass.

Circle **587** on inquiry card.

Glass-Metal Joints. New 2-page Bulletin E-14 presents features, manufacture, uses, and instructions for maker's "Cerroseal-35" alloy for glass-to-glass and glass-to-metal joints.—Cerro de Pasco Corp., 40 Wall St., New York, N. Y.

Circle **588** on inquiry card.

Miniature Ball Bearings. New set of 6 bulletins describe, illustrate, and give specifications of maker's miniature bearings. Includes radial and axial clearances, how bearings are used in radar antenna, and specifications on miniature ball bearings.—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **589** on inquiry card.

Solders. New 4-page Bulletin FF 12M presents features and applications of maker's high-strength fusion paste-alloy solders for high-speed electrical and hermetic connections.—Fusion Engineering, 4504 Superior Ave., Cleveland, Ohio.

Circle **590** on inquiry card.

Production Aids and Machinery. New 24-page illustrated bulletin describes maker's basic work centers, parts containers, conveyor transports and remote facsimile bulletin boards. Includes specifications.—Alden Systems Co., Westboro, Mass.

Circle **591** on inquiry card.

Vibration Mounts. New 4-page Catalog MB-110 covers maker's airborne mounting bases, vibration isolators, and shock mounts.—T. R. Finn & Co., Inc., 333 Jackson St., New York, N. Y.

Circle **592** on inquiry card.

Tube-pin Straightener. New 2-page bulletin describes and illustrates maker's tube-pin straighteners, soldering aid, tube lifter, probing tweezers and other serviceman's aids.—CBS-Hytron, Danvers, Mass.

Circle **593** on inquiry card.

Precision Drilling Machine. New 4-page Bulletin V-53 presents maker's "Varimatic" small-hole drilling machine.—Hamilton Tool Co., 902 Hanover St., Hamilton, Ohio.

Circle **594** on inquiry card.

Machine Tools. New Bulletin 3251-CD describes and illustrates a wide variety of maker's machine tools and accessories.—South Bend Lathe Works, South Bend 22, Ind.

Circle **595** on inquiry card.

Precision Small Tools. New 16-page catalog lists maker's precision small parts, such as dies, drills, reamers, counterbores, and jig bores, including prices.—R. Y. Ferner Co., Inc., 110 Pleasant St., Malden, Mass.

Circle **596** on inquiry card.

Rolling Mills. New 8-page Bulletin 121 describes and illustrates maker's 3-in. and 4-in. laboratory and production rolling mills.—Stanat Mfg. Co., Long Island City, N. Y.

Circle **597** on inquiry card.

Milling Machines. New 6-page Bulletin 101 describes and illustrates maker's precision milling machines.—Nichols-Morris Corp., 76 Mamaroneck Ave., White Plains, N. Y.

Circle **598** on inquiry card.

Screw Drivers. New 12-page folder describes and illustrates maker's break-proof and shock-proof screw drivers.—Vaco Products Co., 317 E. Ontario St., Chicago, Ill.

Circle **599** on inquiry card.

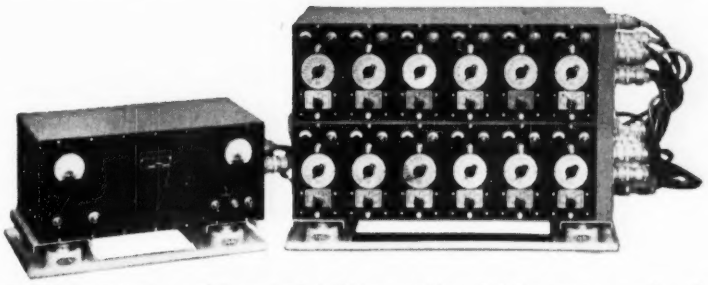
Write-on Tapes. New 4-page Bulletin 11 describes and illustrates maker's plastic, self-sticking write-on tape.—Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester, N. Y.

Circle **600** on inquiry card.

Stainless-steel Fasteners. New 20-page Catalog 53-B describes and illustrates maker's in-stock inventory of cap screws, nuts, washers, machine screws, etc.—Star Stainless Screw Co., 190-A Union Ave., Paterson, N. J.

Circle **601** on inquiry card.

Century VIBRATION AND STRESS ANALYSIS SYSTEM



The Century Vibration and Stress Analysis System provides all of the necessary equipment to amplify and record vibration and stress-strain phenomena over a frequency range from 0 to 2000 cps.

Two modes of measurements are used in covering this system: (a) a carrier amplifier system to measure phenomena in the range of 0-500 cps, utilizing externally excited pick-ups as the sensing element; and (b) a linear-integrating amplifier system covering the range of 3-2000 cps, utilizing self-generating pick-ups, or d.c. excited strain gages employed dynamically. Both of these modes utilize either the Century Model 408 or 409 Oscillograph.

Write for Bulletins.

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA

For more information circle **145** on inquiry card.

ALFAX UNIVERSAL RECORDING PAPER

For the first time, there is available an indelible recording paper—ALFAX—that is NOT subject to humidity, temperature or capillary action problems usually associated with pen and ink or papers marked by arcing or heat.

ELECTRICITY IS THE INK THAT MARKS ALFAX

Alfax paper can be marked by current as low as one volt and is instantaneous, permanent and stable. Highly sensitive Alfax is capable of fourteen steps by simply varying the current through the paper.

Alfax is the only paper that is capable of high speed recording, stable before or after recording, is non-transferable, has low current consumption at high speeds, can record at high humidity over all temperature ranges, is smudge proof and nontoxic, widths from ¼" to 72".

Alfax opens a whole new field of monitoring and recording of phenomena which never before have been done easily and cheaply.

THIS MONTH'S EXAMPLE

Using "electricity as the ink" a ⅛" stylus traveling across Alfax paper at 1/3 mile per minute produces 4 ft. wide bulletin emerging at rate of 3 feet per minute. Operated by ordinary AC current.

Request Booklet—describe your problem

Alfax Paper & Engineering Co.
Alden Research Center, Westboro, Mass.
ENGINEERING SERVICE TO RECORDER MANUFACTURERS

For more information circle **146** on inquiry card.

PHAZOR Pat. Pend. PHASE METER MODEL 200A

$349.50 F.O.B. New York, N. Y.

Measures phase shift in transformers, amplifiers, filters, and phase displacement networks.

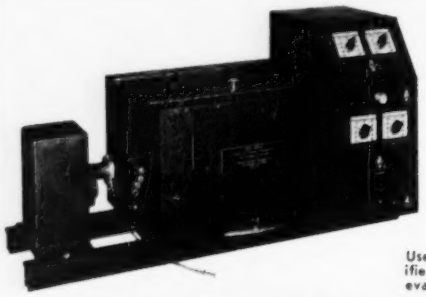
- Measures from 0 to 360 degrees.
- Readings not affected by noise and harmonics.
- Phase shifts of the order of .01 degree can be measured employing special circuit techniques.
- Measures in-phase and quadrature components separately.

SPECIFICATIONS

Accuracy—Basic accuracy plus or minus 2 degrees. Plus or minus 1 degree due to meter error.
Noise and Harmonic Rejection ..... 40 db. down
Sensitivity ..... 6 millivolts full scale
Maximum Input Voltage ..... 125 volts RMS
Peak Input Signal ..... 400 volts
Frequency Range ..... 20 to 20,000 cps.
Input Impedance
High Gain 2.0 megohm shunted by 25 mmfd.
Low Gain 2.5 megohm shunted by 10 mmfd.
Reference Input Impedance ..... 4000 ohms
Power Supply ..... 105 to 125 volts, 60 cps., 25 watts
Dimensions—Length 15 in., Hgt. 9 in., Depth 8 in.
Weight ..... 25 pounds

INDUSTRIAL TEST EQUIPMENT CO.
55 EAST 11th ST., N. Y. 3 - Tel: GR. 3-4684

For more information circle **147** on inquiry card.



For Molecular Weight and Size Determination

New—Improved

Dual Photomultiplier Type

LIGHT SCATTERING PHOTOMETER

For Measuring

- **ABSOLUTE TURBIDITY**
- **DISSYMMETRY**
- **DEPOLARIZATION**

Improved Circuit
Will Operate 5 MV Recorder

Use of the Brice-Phoenix instrument is specified in U. S. Govt. specifications for the evaluation of certain clinical materials.

Phoenix Precision Instrument Co.

3803 N. 5th St., Philadelphia 40, Pa.

For more information circle **148** on inquiry card.

Well-known English Instrument Manufacturing Company wishing to expand still further seeks manufacturing rights, under licence or similar arrangement, of suitable American Instruments preferably though not absolutely necessarily of the type which are not obtainable in Great Britain. Any communication on this matter would be treated in the strictest confidence. Box G.A. 978, 4 Salisbury Court, Fleet Street, London, E.C.4, England.

Engineer or Physicist for Instrumentation on experimental projects involving measurement of dynamic and transient phenomena. Good knowledge of theory of instruments and three years of instrument experience required. Some military work (U.S. citizens only). Mobility handicaps acceptable. Write Engineering Mechanics Department, Southwest Research Institute, P. O. Box 2296, San Antonio, Texas.

SWISSOMATIC PRODUCTS
BETTER PARTS

WANTED

Experienced Set-Up Men and Operators for Swiss Automatic Screw Machines

* * *

Only men who command top wages need apply.

* * *

SWISSOMATIC PRODUCTS
1818 STANFORD STREET,
SANTA MONICA, CALIF.
EXbrook 56772
From L. A. phone TExas 03031

SALES ENGINEERS

Unique opportunity to get in on ground floor of young successful company applying atomic energy to industrial uses (non-government).

Young graduate engineers with successful experience selling capital goods or control equipment needed for openings in Pittsburgh, Southern Ohio, Chicago, and Southern United States. Salary and commission. Send complete resume to:

INDUSTRIAL NUCLEONICS CORP.
1205 Chesapeake Avenue
Columbus 12, Ohio

The acknowledged leader in the field of development and manufacture of nuclear measurement and control equipment for heavy industry.

PATENT ASSISTANT—B.S., E.E.
E.E., CIRCUIT DESIGNER
E.E., TEST ENGINEER
PHYSICIST—ION OPTICS
MECHANICAL DESIGNER
FIELD APPLICATION ENGINEER (CHEMICAL)

Whether a native Californian or interested in locating here, you can't go wrong checking Beckman's few career positions now open. Our expansion of firm commercial business of building some of the world's finest scientific instruments can assure you of a secure future.

If the positions above fit your interest and abilities, communicate with our Technical Employment Manager.

BECKMAN INSTRUMENTS, INC.
1001 El Centro
South Pasadena 3, Calif.

NEW LITERATURE

Maintenance Control Systems. New 8-page booklet, "Assured Equipment Productivity through Maintenance Management" lists requirements for establishing a system for repair, construction, and preventive programs in industry.—Remington Rand Inc., 315 Fourth Ave., New York, N. Y.

Circle **602** on inquiry card.

Process Equipment Fabrication. New 6-page illustrated Bulletin 10 covers range of products and facilities for custom fabrication of steel and special-alloy equipment.—Quaid Fabrications, Inc., 157 W. Oxford St., Phila., Pa.

Circle **603** on inquiry card.

Metal Stampings. New 24-page illustrated bulletin describe's maker's method for producing metal stampings in small lots. Gives examples of services.—Dayton Rogers Mfg. Co., Minneapolis 7, Minn.

Circle **604** on inquiry card.

Absorptive Lenses. New 2-page Bulletin N-350 describes maker's "Neophan" absorptive lenses which screen yellow sodium light rays and ultraviolet rays and protect eyes of glass blowers, aluminum welders, and other workers near sodium flame.—Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N. Y.

Circle **605** on inquiry card.

Shears. New 14-page illustrated Bulletin D-S1 covers maker's manually-operated and power shears. Includes operating and maintenance instructions.—O'Neil-Irwin Mfg. Co., 300 Eighth Ave., Lake City, Minn.

Circle **606** on inquiry card.

Midget Torque Screwdriver. New 2-page bulletin describes and illustrates maker's "Model J" midget torque screwdriver with predetermined torque setting.—Overload Control Co., 260-11 Langston Ave., Glen Oaks, L. I., N. Y.

Circle **607** on inquiry card.

Compressors. New 6-page Bulletin 600 describes and illustrates maker's compressors said to compress air entirely free of oil or oily vapor.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Circle **608** on inquiry card.

Seamless Deep-drawn Boxes. New 16-page Catalog No. 4 lists 750 standard sizes of seamless, deep-drawn aluminum, steel, and brass containers.—Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Circle **609** on inquiry card.

Diamond Drilling. New 8-page issue of "Horse Head Bulletin" describes use of diamond drilling apparatus in geological surveys; also fume-collection apparatus in smelting plant.—New Jersey Zinc Co., 160 Front St., New York, N. Y.

Circle **610** on inquiry card.

ADVERTISERS' INDEX

A

Acragage Corporation 1932
Acromark Company 1928
Advance Electronics Co. 1930
A'G'A Division of Elastic Stop Nut Corp. of America 1915
Alfax Paper & Engineering Company 1933
American Instrument Co., Inc. 1903
American Machine & Metals, Inc. 1815, 1839
American Meter Company ..... Inside Front Cover
Amperite Co., Inc. 1919
Amthor Testing Instrument Co. 1931
Arnold Engineering Co. 1794
Assembly Products, Inc. 1899
Avion Instrument Corp. 1858

B

Bailey Meter Co. 1885
Baldwin-Lima-Hamilton Corp. 1806
Barber-Colman Company 1801
Beckman Instruments, Inc. 1934
Black, Sivalls & Bryson, Inc. 1795
Bristol Company 1796-1797, 1812
Brown Electro-Measurement Corp. 1851
Brush Electronics Company 1792
Burling Instrument Co. 1856
Burlington Instrument Co. 1925
Burroughs, Electronic Instruments Div. 1833

C

Cambridge Instrument Co., Inc. 1905
Century Geophysical Corp. 1933
Cerro de Pasco Corp. 1914
Chace Co., W. M. 1861
Cinema Engineering Company 1908
Consolidated Engineering Corp. 1820
Cramer Co., Inc., R. W. 1904

D

Dahl Company, George W. 1902
DeJur Amsco Corporation 1867
Dialight Corporation 1900
Doelcam Corporation 1831

E

Edcliff Instruments 1930
Electric Auto-Lite Co. 1924
Electro-Mec Laboratory 1864
Electro Products Laboratories 1923
Eppley Laboratory, Inc. 1851
Exact Weight Scale Co. 1871

F

Falstrom Company 1790
Fielden Instrument Division 1807
Fischer & Porter Co. 1821
Fisher Governor Co. 1804-1805
Foster Engineering Company 1829
Foxboro Company 1802-1803, 1906, 1911
Fusite Corporation 1869

G

General Electric Company 1808-1809, 1841
Gordon Co., Claud S. 1850
Gotham Instruments, Div. of American Machine & Metals, Inc. 1839
Gow-Mac Instrument Co. 1906
Green Instrument Co. 1922

INSTRUMENTS

The Magazine of Measurement and Control
OFFERS YOU
A BALANCED DIET

Regular issues contain articles on various subjects within the great and growing field of Measurements, Analysis, Computing, Inspection, Testing, Metering and Automatic Control. Engineers, Production Managers as well as Research Men and Executives find *Instruments*, with its balanced diet, a source of valuable practical information.

The regular subscription price is $4.00, *BUT*:

On two or more new subscriptions or renewals sent together on one order the rates will be reduced as follows:

2 separate one-year subscriptions	$ 6.00
3 separate one-year subscriptions	7.50
4 separate one-year subscriptions	9.00
5 separate one-year subscriptions	10.00

SO YOU SEE—If five or more of you subscribe or renew together, the cost of each one-year subscription will be only $2.00. No subscriptions can be entered which do not give complete information.

Your Inquiry Card →

A supply of these cards for the asking

Is your copy of *Instruments* routed to several people?

Does your Company Librarian forbid mutilating tech mags?

Or do you yourself wish to preserve your own copies intact?

Just check square on inquiry card and we'll send you twelve! DO IT NOW.

INSTRUMENTS PUBLISHING CO.
845 RIDGE AVENUE, PITTSBURGH 12, PA.

I am sending the subscriptions for *Instruments* listed below. Please invoice me according to the above special rates.

Signed .....
Address .....

Name ..... Position .....
Company .....
Address .....
Products Manufactured .....

Name ..... Position .....
Company .....
Address .....
Products Manufactured .....

Name ..... Position .....
Company .....
Address .....
Products Manufactured .....

Name ..... Position .....
Company .....
Address .....
Products Manufactured .....

Name ..... Position .....
Company .....
Address .....
Products Manufactured .....

INSTRUMENTS

INFORMATION CARD—DECEMBER '53

Not good after February 1, 1954

Check square for extra cards: ☐

For further details concerning developments reported in advertisements, New Product or New Literature reviews, CIRCLE THE NUMBER corresponding to that which appears with the ad or write-up.

please fill in the following COMPLETELY:

Name..... **Title**.....

Company .....

Address..... **City**..... **Zone**..... **State**.....

Advertised Products

1	21	41	61	81	101	121	141
2	22	42	62	82	102	122	142
3	23	43	63	83	103	123	143
4	24	44	64	84	104	124	144
5	25	45	65	85	105	125	145
6	26	46	66	86	106	126	146
7	27	47	67	87	107	127	147
8	28	48	68	88	108	128	148
9	29	49	69	89	109	129	149
10	30	50	70	90	110	130	150
11	31	51	71	91	111	131	
12	32	52	72	92	112	132	
13	33	53	73	93	113	133	
14	34	54	74	94	114	134	
15	35	55	75	95	115	135	
16	36	56	76	96	116	136	
17	37	57	77	97	117	137	
18	38	58	78	98	118	138	
19	39	59	79	99	119	139	
20	40	60	80	100	120	140	

New Products

201	221	241	261	281	301	321	341
202	222	242	262	282	302	322	342
203	223	243	263	283	303	323	343
204	224	244	264	284	304	324	344
205	225	245	265	285	305	325	345
206	226	246	266	286	306	326	346
207	227	247	267	287	307	327	347
208	228	248	268	288	308	328	348
209	229	249	269	289	309	329	349
210	230	250	270	290	310	330	350
211	231	251	271	291	311	331	
212	232	252	272	292	312	332	
213	233	253	273	293	313	333	
214	234	254	274	294	314	334	
215	235	255	275	295	315	335	
216	236	256	276	296	316	336	
217	237	257	277	297	317	337	
218	238	258	278	298	318	338	
219	239	259	279	299	319	339	
220	240	260	280	300	320	340	

New Literature

401	421	441	461	481	501	521	541	561	581	601
402	422	442	462	482	502	522	542	562	582	602
403	423	443	463	483	503	523	543	563	583	603
404	424	444	464	484	504	524	544	564	584	604
405	425	445	465	485	505	525	545	565	585	605
406	426	446	466	486	506	526	546	566	586	606
407	427	447	467	487	507	527	547	567	587	607
408	428	448	468	488	508	528	548	568	588	608
409	429	449	469	489	509	529	549	569	589	609
410	430	450	470	490	510	530	550	570	590	610
411	431	451	471	491	511	531	551	571	591	
412	432	452	472	492	512	532	552	572	592	
413	433	453	473	493	513	533	553	573	593	
414	434	454	474	494	514	534	554	574	594	
415	435	455	475	495	515	535	555	575	595	
416	436	456	476	496	516	536	556	576	596	
417	437	457	477	497	517	537	557	577	597	
418	438	458	478	498	518	538	558	578	598	
419	439	459	479	499	519	539	559	579	599	
420	440	460	480	500	520	540	560	580	600	

ADVERTISERS' INDEX

Continued from page 1935

H

Hagan Corporation 1798-1799
Hammel-Dahl Co. ..... Back Cover
Hathaway Instrument Company 1931
Hays Corporation 1818
Heise Bourdon Tube Co. 1930
Helicold Gage Div. 1921
Helipot Corporation, Division of Beckman Instruments, Inc. 1911
Hexacon Electric Co. 1866
Hoke Incorporated 1865

I

Illinois Testing Laboratories, Inc. 1911
Industrial Div., Minneapolis-Honeywell Regulator Co. 1817, 1862-1863
Industrial Nucleonics Corp. 1934
Industrial Test Equipment Co. 1933
Industrol Corp. 1927
Instrof Incorporated 1860
Instrument & Control Consultants 1917
Instruments Publishing Co. 1915
International Rectifier Corporation 1910

J

Johnson-Williams, Ltd. 1852

K

Kern Chemical Equipment Company 1866
Kemp Mfg. Co., C. M. 1914
Kendall Controls Corp. 1905
Kieley & Mueller, Inc. 1813
Klipfel Valves, Inc. 1910
Kybernetes Corporation 1787

L

Leeds & Northrup Co. 1824
Levin & Son, Inc., Louis 1904
Lewis Engineering Co. 1791
Librascope, Inc. 1844
Logan Engineering Co. 1907

M

Mallory & Co., Inc., P. R. 1800
Manning, Maxwell & Moore, Inc. 1847
Marsh Instrument Co. 1909
Marshalltown Mfg. Co. 1908
Mason-Neilan Regulator Co. 1886
Measurements Corp. 1856, 1931
Meriam Instrument Co. 1869
Midwestern Geophysical Laboratory ..... Inside Back Cover
Minneapolis-Honeywell Regulator Co. 1817, 1862-1863
Moeller Instrument Co. 1871
Monsell, John R. 1929
Moore & Company, Samual 1834

N

Nash Engineering Company 1822
New Hermes Engraving Machine Corp. 1920
North American Philips Company, Inc. 1855

P

Pacific Scientific Co. 1846
Palmer Thermometers, Inc. 1854
Panellit, Inc. 1827
Phoenix Precision Instrument Co. 1924, 1934
Pittsburgh Lectrodryer Corporation 1816
Preis Engraving Machine Co., H. P. 1932
Pyrometer Instrument Co. 1898

R

Rochester Mfg. Co., Inc. 1929

S

Sanborn Co. 1843
Schaevitz Engineering 1926
Schutte & Koerting Co. 1819
Scott-Rice Co. 1898
Servo Corporation of America 1925
Shallcross Manufacturing Co. 1859
Shore Instrument & Mfg. Co. 1928
Southwest Research Institute 1934
Spellman Television Corp. 1907
Statham Laboratories 1848
Stevens-Arnold Incorporated 1922
Streeter-Amet Co. 1909
Struthers-Dunn, Inc. 1857
Sturtevant Co., P. A. 1926
Superior Tube Company 1793
Swartwout Company 1913
Swissomatic Products 1934
Sylvania Electric Products Inc. 1927

T

Taylor Instruments Companies 1810-1811
Telecomputing Corporation 1823
Texas Instruments, Incorporated 1920
Thermco Laboratories 1909
Thermo Electric Co., Inc. 1923
Tigerman Engineering Company 1901
Trinity Equipment Corp. 1864

U

Uehling Instrument Co. 1924
Unertl Optical Co., John 1926
Uniform Tubes 1853
United States Gauge, Div. of American Machine & Metals, Inc. 1815
United States Radium Corp. 1837

V

Veeder-Root Inc. 1814

W

Wabash Metal Products Co. 1918
Walkirt Co. 1909
Wallace & Tiernan Products, Inc. 1845, 1907
Webber Manufacturing Company, Inc. 1907
Weksler Thermometer Corporation 1911
Weston Electrical Instrument Corp. 1849
White Instruments Laboratories 1932

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c-POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

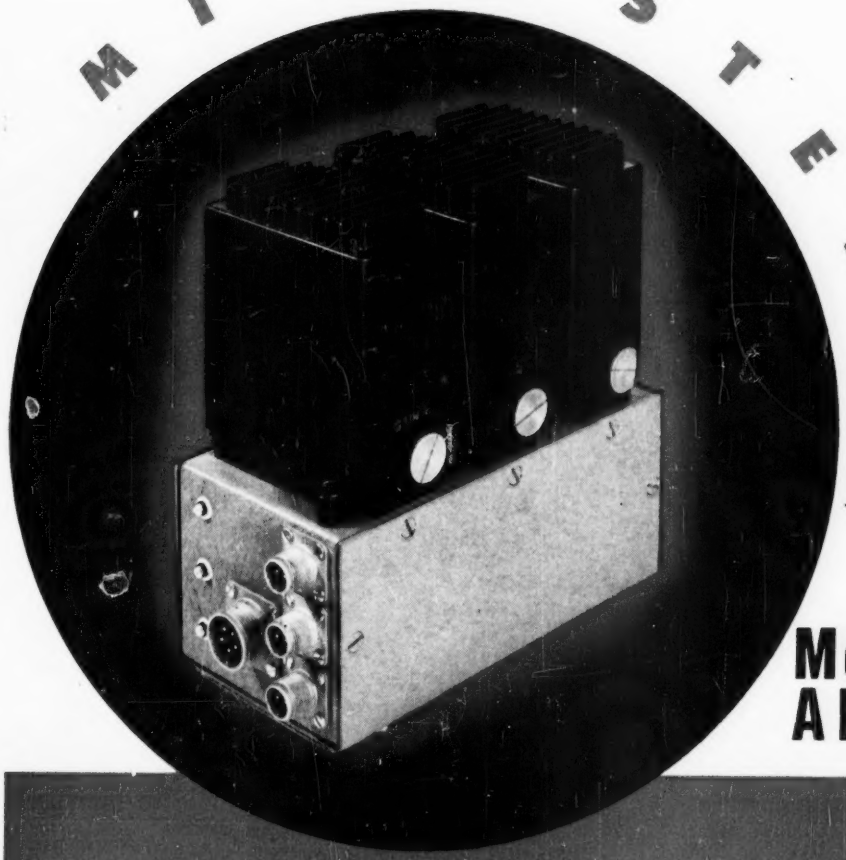
BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c-POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

MIDWESTERN



Model GA-1R AMPLIFIER

A high-gain, pressure-proof, ruggedized amplifier having a substantially flat frequency response in the sub-audio and audio range of frequencies. It was designed in answer to many requests for an amplifier of this type which would be capable of driving the Midwestern Model 102-3500 and 102-5000 galvanometers and similar devices from high-impedance, low-signal-level measuring instruments such as accelerometers, velocimeters, pressure pickups, etc. It will also drive other galvanometers of similar resistance and natural frequencies. It has been designed to operate satisfactorily under 25 g shock conditions and at high altitudes.

The output transformer for the amplifier is located in the base into which the unit is plugged. Bases are available which will accommodate one, two, three or six GA-1R amplifiers.

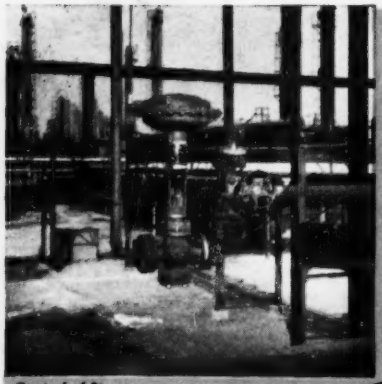
FOR COMPLETE INFORMATION AND PRICE QUOTATIONS, PHONE, WIRE OR WRITE

"You Can Rely on Midwestern"

3401 SOUTH HARVARD • TULSA, OKLAHOMA

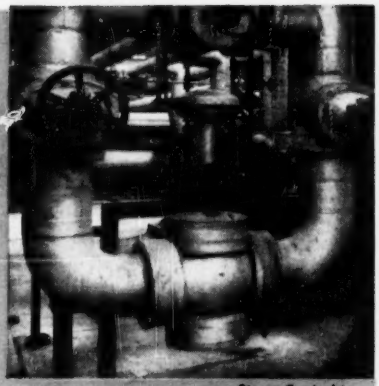
MIDWESTERN
GEOPHYSICAL LABORATORY

For more information circle **149** on inquiry card.



Control of Steam to Vacuum Jet

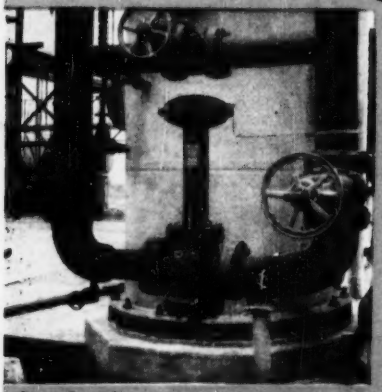
FOR CRITICAL PROCESS CONTROL



Steam Control to Flash Tower

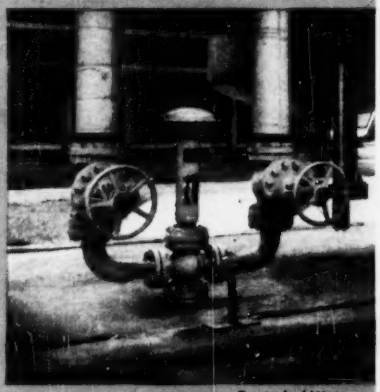
Celanese

REG. U.S. PAT. OFF.



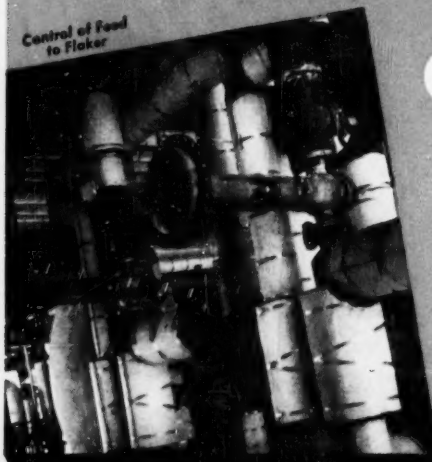
Steam Control to Reboiler

USES



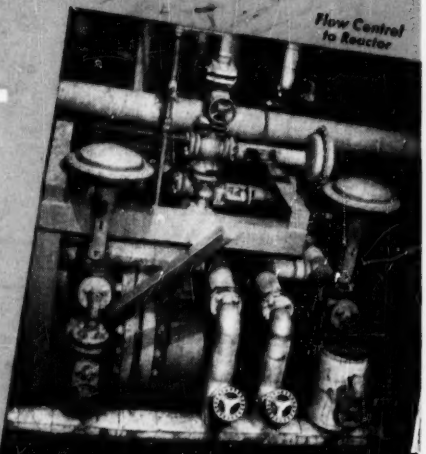
Control of Water to Waste Heat Boiler

HAMMEL-DAHL



Control of Feed to Flaker

CONTROL VALVES



Flow Control to Reactor

OUR CATALOG "B" WILL HELP SOLVE PROCESS CONTROL PROBLEMS

Write For Your Copy Today

HAMMEL-DAHL COMPANY

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

For more information circle **150** on inquiry card.